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bST and the Dairy Industry

A National, Regional, and Farm-level Analysis

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ABSTRACT

Cows produce more milk at less cost when injected with bovine Somatotropin (bST), a protein occurring naturally in cattle. Advances in biotechnology now make it possible to produce synthetic bST at commercially attractive prices. Dairy farmers are likely to use synthetic bST since early adopters will realize significantly higher returns and other operators will eventually have to adopt to compete.

But the effects of bST on the dairy industry are likely to be less dramatic than often suggested. Since bST will be available to all operators and little additional capital or operational changes are required, bST use should reinforce, but not fundamentally change, structural trends already underway. One such trend is toward fewer but larger dairy farms. Savings in production costs will eventually be offset by the declines in milk prices generated by larger supplies, if Government support programs allow prices to drop enough to balance production and commercial use. Hence, the effects of bST will largely depend on the flexibility of the price support program. An inflexible program with high supports could mean large Government outlays and accumulating surpluses. bST would have little effect on the U.S. position in the world dairy market under current trade policy. Under more liberal trade policies, U.S. competitiveness could suffer if bST were adopted abroad but not here.

Keywords: Dairy, bovine Somatotropin (bST), growth hormone, technology, biotechnology, dairy industry, economic analysis

PREFACE

The Secretary of Agriculture requested USDA to conduct this study of the potential economic effects of the use of bovine Somatotropin (bST) in dairy cattle. The study analyzes the likely effects on overall milk supplies, milk prices, milk production costs and returns, location and structure of milk production, the dairy price support program, and the U.S. competitive position in world dairy markets. The study analysts extensively reviewed related literature and communicated directly with researchers at universities, in the industry, and in proprietary companies about reasonable assumptions to use in the study. We appreciate the generous sharing of this information, some of which is not yet in the public domain.

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Cows produce more milk at less cost when injected with bovine Somatotropin (bST), a protein occurring naturally in cattle. Advances in biotechnology now make it possible to produce synthetic bST at commercially attractive prices. Dairy farmers are likely to use synthetic bST since early adopters will realize significantly higher returns and other operators will eventually have to adopt to compete.

But the effects of bST on the dairy industry are likely to be less dramatic than often suggested. Since bST will be available to all operators and little additional capital or operational changes are required, bST use should reinforce, but not fundamentally change, structural trends already underway. One such trend is toward fewer but larger dairy farms. Savings in production costs will eventually be more than offset by the declines in milk prices generated by larger supplies, if Government support programs allow prices to drop enough to balance production and commercial use. Hence, the effects of bST will largely depend on the flexibility of the price support program. An inflexible program with high supports could mean significantly higher returns to producers but large Government outlays and accumulating surpluses. bST would have little effect on the U.S. position in the world dairy market under current trade policy. Under more liberal trade policies, U.S. competitiveness could suffer if bST were adopted abroad but not here.

Genetic engineering has made it possible to synthetically produce bST at commercially attractive prices. Injecting bST into dairy cows during the milking cycle significantly and immediately increases milk production without any apparent effect on cow health or change in milk quality. Several major pharmaceutical companies are researching how well bST works and whether it is harmful to animal health in the long term. Company funded and independently funded research is also underway in several universities. The Food and Drug Administration (FDA) requires this information before it can rule whether bST can be manufactured for commercial use.

Adoption of bST, when viewed at the national level, simply reinforces the 30-year trend toward increased milk production per cow and declining dairy farm numbers. When viewed at the farm level, bST use could prove profitable for almost all commercial dairy farms. But inefficient producers who lack management skills and who do not adjust feeding and health procedures to reflect increased milk production from bST-treated cows are not likely to capture all of bST's potential benefits. Hence, bST will not significantly affect the national trend towards larger dairy farms in all regions.

This report evaluates the performance of the dairy industry from 1990 to 1996 with and without the use of bST to enhance milk production. We assume that FDA will approve commercial use of bST, that bST will be introduced commercially in early 1990, and that the effect of adopting bST will work its way through the sector by 1996. The study focuses on the effects of bST on milk supplies, commercial use, milk prices, dairy industry structure, the dairy price support program, and the international competitive position of the U.S. dairy industry. We give particular attention to analyzing the effects of bST on dairy industry structure—the survivability of farms of different sizes in different regions with varying debt loads and management skills.

We developed four Government policy scenarios as a backdrop for analyzing trends in the dairy industry through 1996 with and without bST (see box). Figure 1 illustrates how dairy policy (especially price support levels) and the dairy farm sector interact. With the current dairy program continued and supports adjusted downward as provided for in the Food Security Act of 1985 (Scenarios I and II), cow numbers drop 9–10 percent and farm numbers drop 12–14 percent by 1996 from 1989 levels with or without bST (table 1). The major difference between bST and non-bST projections is the amount of Government purchases. With a minimum support price between $9.60 and $10.10 per hundredweight (cwt), bST increases Government purchases approximately 8 billion pounds by 1996.

If price supports are allowed to fall to balance production and use (Scenario III), consumers are the major beneficiaries of the efficiency gains resulting from bST use. Scenario III allows the dairy support price to adjust over time so that, even with bST, production and commercial use are approximately in balance by 1996. Government purchases fall below 5 billion pounds after 1994 even with bST. By 1996, the all-milk price with bST drops 9 percent; without bST it increases 3 cents per cwt. With bST, cow numbers drop an additional 315,000 (3 percent), and farm numbers also drop an additional

A LOOK AT SUPPORT PRICES AND POLICY SCENARIOS

Support pricing is a key component of a complex dairy program. The level of *price supports* is established by legislation. The Government purchases surplus dairy products in order to support the price of *manufacturing-grade milk* (milk used to produce butter, cheese, and nonfat dry milk). However, the support price also affects the price of *fluid-grade milk* (the milk we drink) because the manufacturing-grade milk price is the underlying basis for determining the price of higher valued fluid-grade milk. The weighted national average price of fluid- and manufacturing-grade milk is the *all-milk price*, and is generally about $1 above the manufacturing-grade milk price.

Four alternative policy scenarios were tested to gauge the effect of bST with different price support levels. Each scenario is considered with bST and without bST.

Scenario I assumes a support price for manufacturing-grade milk of $10.10 per cwt in 1990 when bST is introduced. No further adjustments are allowed through 1996.

Scenario II assumes a support price of $9.60 by 1990 when bST is introduced. This figure is the statutory price reduction limit of the Food Security Act of 1985. No further changes in the support price are assumed through 1996.

Scenario III, following current provisions of the 1985 Act and extending them through 1996, also assumes a support price of $9.60 in 1990. This scenario then allows two further 50-cent annual reductions in the support price (not provided for in the 1985 Act) if Government purchases are projected to exceed 5 billion pounds in any calendar year. The lowest support price allowed in this scenario is $8.60.

Scenario IV maintains the support price at the October 1987 level of $11.10 per cwt through 1996, regardless of supply and demand conditions and Government purchases. This scenario allows more marginal producers to stay in business.

3 percent compared with the non-bST trend. By 1996, the all-milk price with bST is $1.06 per cwt (9 percent) below the all-milk price without bST.

With Scenario IV's high support levels ($11.10 per cwt), the all-milk price is similar with and without bST. With bST, farm numbers in 1996 are about 4 percent higher than without bST, and cow numbers are 2 percent higher. Even though more small- and medium-sized farms would remain viable with higher support prices, the trend toward larger herds would continue and the decline in farm and cow numbers would slow to less than 1 percent per year, with and without bST. This slower decline in cow and farm numbers contributes to increasing milk production. Annual Government purchases are high: 31 billion pounds by 1996 with bST and 16 billion pounds without bST. The results vividly illustrate the need for a flexible dairy price support system to accommodate cost-reducing milk supply shifters such as bST.

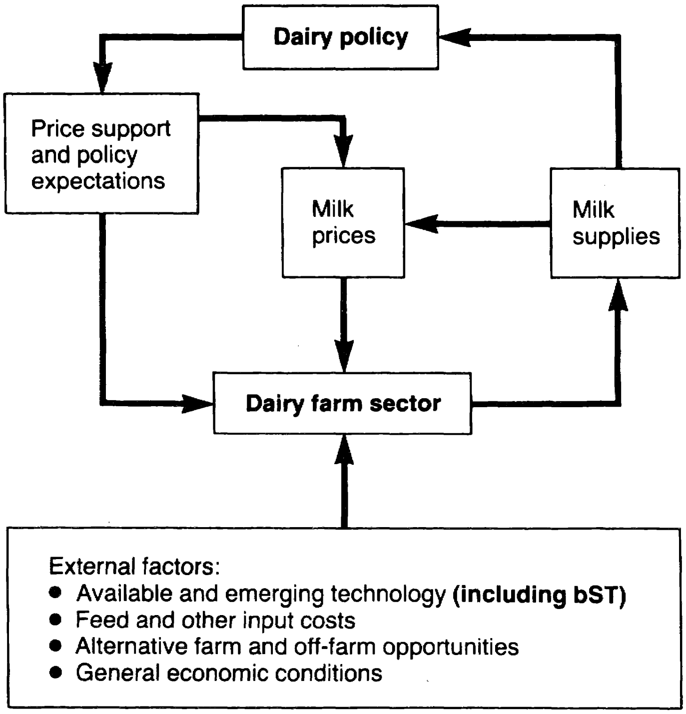
The U.S. dairy industry depends primarily on the domestic market under current policy. Less than 2 percent of U.S. dairy products move abroad, largely through assistance programs that offset high U.S. prices relative to other exporters. Without a substantial change in U.S. trade policies, bST will have little effect on U.S. competitiveness in world dairy markets. However, under a more liberal trade policy opening U.S. markets, the U.S. competitive position would be weakened considerably if bST is not commercially available in the United States, but is used in other countries.

BACKGROUND

bST technology arrives at a time when both the dairy industry and the agricultural sector are making significant resource and financial adjustments. Milk production has exceeded commercial use and normal Government program needs (the School Lunch Program, for

Figure 1

A flexible dairy policy is needed to accommodate emerging technology



example) since the late 1970's. To maintain congressionally mandated milk support prices, the Federal Government has had to purchase large amounts of surplus stocks. As these purchases increased, dairy program revisions made in 1983 and 1985 lowered milk support prices. The price received by dairy farmers has fallen in tandem with support levels. The all-milk price fell from $13.77 per hundredweight (cwt) in 1981 to $12.51 in 1986, a 9-percent decline. The 1985 Act mandates further drops in the support price of 50 cents per cwt on January 1 each year from 1988 through 1990 if Government purchases are forecast to exceed 5 billion pounds in the coming year. Alternatively, if Government purchases in these same years are forecast at less than 2.5 billion pounds, the support price is raised 50 cents per cwt.

bST also arrives on the heels of several decades of structural change related to technological and management advances resulting in rapid and continuing increases in milk output per cow. Bulk milk handling, silo unloaders, and improved milking equipment substantially changed the industry in the 1950's by saving farmers time and labor. Higher rates of concentrate feeding, greater knowledge of animal nutrition, and better quality feeds increased dairy cow productivity. Artificial insemination, progeny testing, and progress in disease control also increased productivity. The development and adoption of bST can be viewed simply as an extension of this trend.

The average cow produced close to 13,000 pounds of milk in 1985, compared with 5,842 pounds in 1955 (table 2). Annual output per cow now exceeds 20,000 pounds for some well-managed herds. These rapid gains in productivity and the economies of size they have made possible have led the industry to concentrate production on fewer, but larger, farms. The number of farms with dairy cows dropped from 2.8 million in 1955 to 272,000

Table 1—Effects of bST on the dairy industry

Scenario and minimum support price	All-milk price	Dairy cows	Dairy farms	Government purchases
	Dollars	Thousand	Number	Billion pounds
Scenario I ($10.10):				
1989	11.13	10,444	165,200	4.9
1996 with bST	10.95	9,513	144,975	11.0
1996 without bST	11.50	9,532	145,408	2.9
Scenario II ($9.60):				
1989	11.13	10,444	165,200	4.9
1996 with bST	10.60	9,394	142,246	8.3
1996 without bST	11.16	9,403	142,353	.5
Scenario III ($8.60):				
1989	11.13	10,444	165,200	4.9
1996 with bST	10.10	9,088	136,621	2.8
1996 without bST	11.16	9,403	142,353	.5
Scenario IV ($11.10):				
1989	12.40	10,577	170,525	13.3
1996 with bST	12.35	10,354	165,801	31.2
1996 without bST	12.46	10,174	160,093	15.6

in 1985, while average herd size grew from 8 cows to 40. Commercial dairy farms (the approximately 175,000 farms with 5 or more cows in 1986) have an average herd size of 65 cows.

bST ISSUES

The issues surrounding this new technology include: (1) Will bST contribute to the trend toward fewer, but larger dairy farms? (2) Will bST contribute to already burdensome milk supplies and budget outlays? (3) Could bST hurt consumer demand for milk? Such issues can be resolved only by long-term research and extended practical experience. The limited long-term research currently available is open to many interpretations.

Industry Structure

Will bST affect the trend toward fewer, but larger, dairy farms? Most research indicates that the "fewer but larger" trend will continue in all regions, especially in the South and West, whether or not bST is available for commercial use. Cases can be presented both for the view that bST will enhance trends toward larger scale farms and for the alternative view that smaller farms can realize equal or better benefits from bST.

Most researchers believe that better managed farms will benefit the most from bST and that bST will offer little help to (or may even hurt) poorly managed farms unable to deal with feeding and other herd management issues. Some data show that larger herds generally produce more milk per cow. If output per cow is related to an operator's management skills, the implication is that larger farms are better managed than smaller farms. If this is true, adoption of bST should reinforce the trend to larger herds.

Some researchers believe that any size operation can easily adopt bST since it does not require substantial capital outlay or change in farm operation. Furthermore, some research shows that low- and high-producing cows respond equally to bST treatment. Therefore, even if smaller farms generally have lower output per cow, they can improve returns with bST, possibly more than large farms. And there are small farms with high output per cow, indicating that good management is not limited to larger herds.

Table 2--Dairy industry changes, 1955-85

Item	1955	1975	1985	Percentage change per year 1/ 1955-75	1975-85
		Thousand		Percent	
Cows	21,044	11,139	11,016	-3.1	-0.1
Farms with milk cows	2,763	444	272	-8.7	-4.7
		Number			
Average cows per farm	8	25	40	5.9	4.8
		Pounds			
Milk per cow (annual)	5,842	10,360	12,994	2.9	2.3
		Million pounds			
Total milk production	122,945	115,398	143,147	- .3	2.2

1/ Compound annual rate.

Climate may affect production response to bST. Some research shows smaller responses to bST under hot, humid conditions. Thus, southern regions may not benefit from bST as much as the cooler Upper Midwest and Northeast, especially during the summer. However, these were short-term studies; researchers speculate that southern responses in longer term trials may be more in line with northern responses because stressful periods of heat and humidity do not usually last long.

One study indicates that bST could even help dairies in the southern regions because bST treatment partly alleviated the usual drops in milk production during hot, humid weather. In addition, some potential heat stress areas like the Southwest already have greater annual output per cow.

Again, if output per cow indicates good management, some of these regions will benefit if well-managed herds show a better response to bST. Hence, at least some regional advantages and disadvantages may be offsetting.

Milk Supply

Will bST contribute to already burdensome milk supplies and Government outlays? The cost of bST to farmers, actual farm-level milk yield response, adoption rate by farmers, and Government policy are among the many factors that will influence bST's effect on U.S. milk supplies.

If bST is quickly adopted and milk supplies increase substantially to the point where dairy products accumulate, budgetary outlays will rise as the Government increases its purchases under the price support system. However, a flexible dairy price support system could adjust dairy price support levels downward. Farmers would then receive lower milk prices which in turn would reduce supplies. Thus, Government outlays need not necessarily become burdensome.

Farmers may adopt bST more extensively and more rapidly than they have adopted other technologies, such as bulk tanks, because bST is a relatively simple technology that does not require a large capital outlay. And unlike some technologies such as artificial insemination where results are not seen for several years, bST's effects on milk output (therefore cash income) are quickly seen.

On the other hand, uncertainty about long-term effects on cow health, cow reproduction, and other environmental issues could slow adoption rates. bST use during the first 90 days of lactation may inhibit reproduction, especially in high-producing cows. To avoid or reduce this potential problem, farmers will likely use bST only after the peak lactation period.

Furthermore, farmers who do adopt bST may use it selectively, injecting only cows meeting certain criteria. Thus, the aggregate increase in milk supply could be lower if a smaller proportion of the U.S. cow herd is treated with bST and if the period of bST use during the lactation is shortened.

Another uncertainty is whether milk production response to bST on all dairy farms and in all cows will be similar to controlled research experiments with well-managed, high-producing cows. Even if all farmers adopt bST and use it on all cows, the increase in milk supplies will be limited by the performance of individual cows. Output is less likely to increase as much when bST is used on farms with production or management problems such as nutritional deficiencies, mastitis, and other health problems.

In addition, poor herd recordkeeping could mean that some farmers may not adopt bST because of their inability to accurately detect individual cow response to bST treatment.

Commercial Use

Could bST hurt consumer demand for milk? The balance between milk supply and demand is improving due to declines in milk supply (primarily because of the Dairy Termination Program) and current increases in commercial use. If bST use results in lower milk prices, consumer demand for milk and dairy products would increase further. However, distrust of bST could dampen consumer demand.

FDA has already approved for human consumption the sale of milk and meat from bST-treated cows in FDA-approved research herds. Despite the FDA position, however, consumer perception of the safety and healthfulness of food is more critical to consumer acceptance than are published research findings. Thus, negative publicity could alter consumer perception of milk as a "natural, wholesome product" and hurt commercial use.

Current research shows that the composition of milk from bST-treated cows is not significantly different from milk produced without bST. Consumption of milk and meat products from bST-treated cows has no effect on humans because bST is a protein inactivated by the human digestive process.

MAJOR ASSUMPTIONS

Despite uncertainties over bST use, we assumed specific yield responses, adoption rates, consumption growth, and general economic and policy environments. To reach credible assumptions, we extensively reviewed the available literature and consulted researchers at universities, in the industry, and in proprietary companies. Study assumptions are summarized here.

bST Approval and Production Timeframe

We assume FDA approval of bST for commercial use and product availability by early 1990. At least four pharmaceutical companies are conducting and sponsoring research to obtain FDA approval as soon as possible. Representatives of several companies indicated that 1990 allows a reasonable amount of time for longer term research, production, and marketing. We also assumed that bST is available as a monthly sustained-release injection.

Yield Response Per Cow

We assume milk production per treated cow increases 1,800 pounds per year (13.5 percent of the 1986 average U.S. milk per cow production level of 13,293 pounds). Thus, average daily production would increase 8.4 pounds during the 215-day treatment period. Though documented yield responses in experimental herds range from 0 to 24 pounds, depending on the experiment and dosage, a consensus estimate for experimental herds is an 11.2-pound average increase. We reduced this figure by 25 percent to adjust for farm conditions. The 8.4-pound increase is consistent with results for sustained-release products, the preferred treatment method used in our assumptions. Although actual response will vary from farm to farm, there are no data to quantify this variability. Thus, we assumed that region or operation size do not affect response.

Adoption Rate

We assume that the rate of bST adoption (all other factors being equal) will depend on farmers' expected net returns from bST. We also assume a bST cost to farmers through 1996 of 24 cents per treated cow per day, regardless of milk price. Since farmers' net returns from bST use will depend heavily on the price received for milk, both the rate and pattern of adoption will vary among the four dairy price support scenarios. We assume that the percentage of farms using bST will vary by scenario (beginning with the lowest price support) as follows:

	1990	1991	1992	1993	1994	1995	1996
				Percent			
Scenario III ($8.60)	10	20	35	43	45	45	45
Scenario II ($9.60)	10	20	36	43	47	50	50
Scenario I ($10.10)	10	20	36	44	48	52	55
Scenario IV ($11.10)	12	33	52	63	66	68	70

These adoption patterns allow most of the effects of adopting bST to work their way through the sector by 1996. Because of a lack of data to the contrary, we assume there are no differences in region or size of operation between early or late adoptors and nonadoptors. We assume that all farms adopting bST will use the product on all cows in their herds. If farm operators use bST on only a portion of their herd, the overall aggregated effects will be less than indicated here.

bST Costs

Pharmaceutical companies indicated that regardless of development, production, distribution, and marketing costs, dairy farmers will not likely adopt bST unless they can obtain a $2 net return for each $1 in bST purchase cost. We projected costs of bST to farmers using 1986 residual returns developed from costs and returns analysis. The actual price that pharmaceutical companies would charge is unknown. The 8.4-pound-per-day additional milk production from bST translates into an estimated bST market price of 24 cents per treated cow per day, assuming 1986 milk prices, economic conditions, and output per cow and a $2 net return for each $1 in bST cost.

Feed Use

We assume farmers will adjust feeding to meet the added nutritional requirements of bST use. Although bST increases a cow's milk production which in turn requires more feed, the animal's feed efficiency (milk output per pound of feed) improves.

Other Assumptions

We assume long-term animal health and reproduction effects are minimal. Consumer acceptance of the milk product is not affected. Production or availability of bST was not constrained.

METHODOLOGY

The analytical methodology underlying this study is complex due to the industry structure questions being asked. We linked two computer models to study the operation of the dairy sector and to simulate adoption and nonadoption scenarios with different policy assumptions. The first is a national model of the dairy industry which simulates aggregate milk supply, demand, prices, and Government purchases. The second, a farm-level model, is based on 150 individual representative farms we developed to evaluate the operation of "typical" dairy farms by size and region. Representative farm models were developed for the Lake States, Northeast, Southeast, Southern Plains, Corn Belt, Appalachian, and Pacific regions. Linking the farm-level and industry models provides a consistent basis for tracing alternative policy assumptions and supply, demand, and price projections through to farm-level structural adjustments, and vice versa.

The linkage between the two models is critical and works through adjustments in milk prices and cow numbers (fig. 2). The interaction between the industry model and the farm-level model generates estimates of milk supply, demand, price, and Government purchases that are consistent with the structural estimates of the number and size of dairy farms by region.

In addition to the models described above, we used USDA's regional costs and returns framework to gauge the profitability of onfarm bST use under 1986 conditions. We also used this framework to estimate the market costs of bST. The 1986 costs and returns estimates for bST should not be confused with the projected analysis of bST for 1990-96 because of changing prices and other variables.

RESULTS

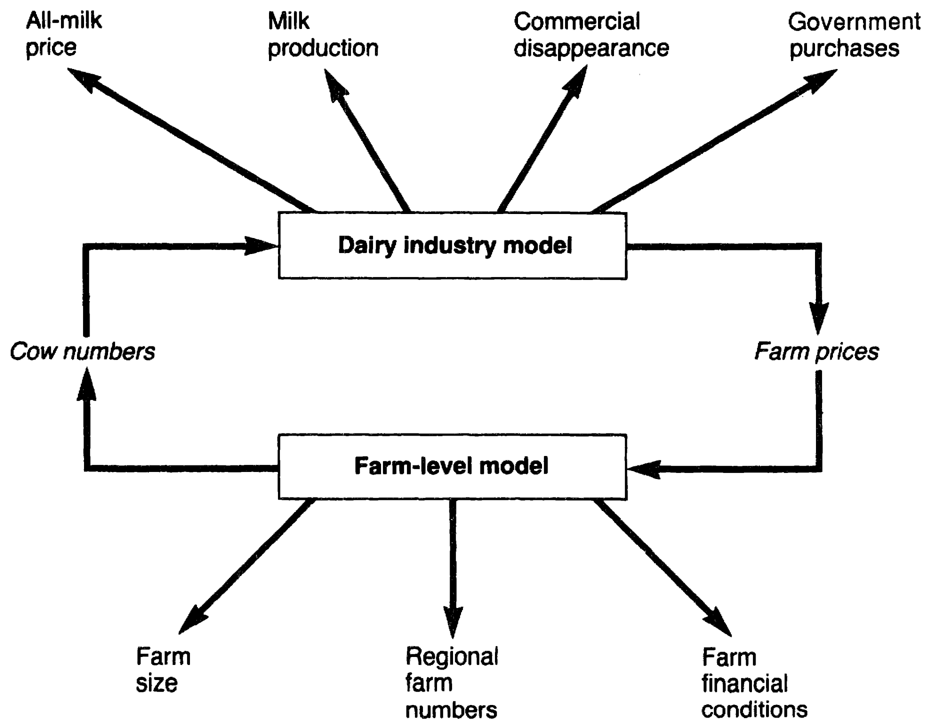
Although bST will be profitable for individual dairy farms to adopt, widespread adoption would increase milk supplies and reduce prices if supports were allowed to adjust. These lower prices will inevitably drive some inefficient dairy operations out of business whether or not they use bST.

At 1986 milk price and input cost levels, the initial increase in revenue from the additional milk produced with bST more than offsets added costs in all regions at all response levels. The increased production levels also provide a larger base over which to spread costs, causing the costs per cwt to drop from the base. Thus, in all regions, bST increases residual returns to management and risk per cwt under 1986 conditions.

We reached these conclusions by estimating costs and returns of the dairy enterprise on a per cow and per cwt basis for six regions and for the total United States at different levels of production response to bST. We evaluated the difference in costs and returns with and without bST using milk prices, output per cow, and feed and other input costs for

Figure 2

The link between the dairy industry and farm-level models is dynamic



1986. We present three daily milk response levels--5, 10, and 20 pounds per day--to represent a possible yield range around the 8.4-pound-per-day response assumption.

The potential to reduce costs and improve returns is available to producers in all regions. Some producers, however, will make better use of the new technology than others.

As earlier indicated, this study used a projected cost of bST to farmers of 24 cents per cow per day of treatment. Despite adding this 24 cents to costs of production, bST use reduces overall milk production costs 67 cents per cwt (assuming 1986 conditions).

Because the commercial cost of bST is still uncertain, we looked at how different bST-response levels to a sustained-release treatment affect returns without including a charge for bST. U.S. annual costs of production drop below the 1986 average level of $11.70 per cwt by $0.60, $1.06, or $1.85 per cwt assuming a 5-, 10-, or 20-pound per day response to bST. Based on these figures, a dairy farmer would net up to $13.47, $26.80, or $53.57 per cow per monthly treatment, depending upon the response rate outlined above. These additional earnings from bST use are considerably above bST manufacturers' estimated production costs. Preliminary estimates indicate that one monthly treatment of bST will cost agricultural chemical companies approximately $2 to $4 to produce (excluding product development and marketing costs).

National and Regional Effects of bST

Regardless of policy scenario, bST has little effect on the regional location of milk production or on the relative size of dairy farms (fig. 3). However, the general trend in increased productivity coupled with increasing average herd size has resulted in fewer dairy farms. Although results indicate a significant drop in farm numbers, the reductions are consistent with historical trends.

At current or moderately reduced support prices, farm viability increases for bST users because moderately lower milk prices are more than offset by lower production costs. Large dairies show the most increase in profitability from using bST, despite lower aggregate milk prices. For smaller dairies, bST is profitable at $10.10 and $9.60 dairy price supports. At lower support prices, bST adversely affects viability of inefficient units, compared with a non-bST situation.

bST continues, at a slightly accelerated rate, the long-term annual increase in production per cow. Under bST, productivity increases accelerate in 1990 and diverge from the non-bST trend. Milk supplies increase 2-5 percent annually over 1990-92 relative to the non-bST trend, depending on the support price. By 1993, the Nation's milk supply ranges from 4 percent (Scenario III) to 10 percent (Scenario IV) higher than the non-bST level.

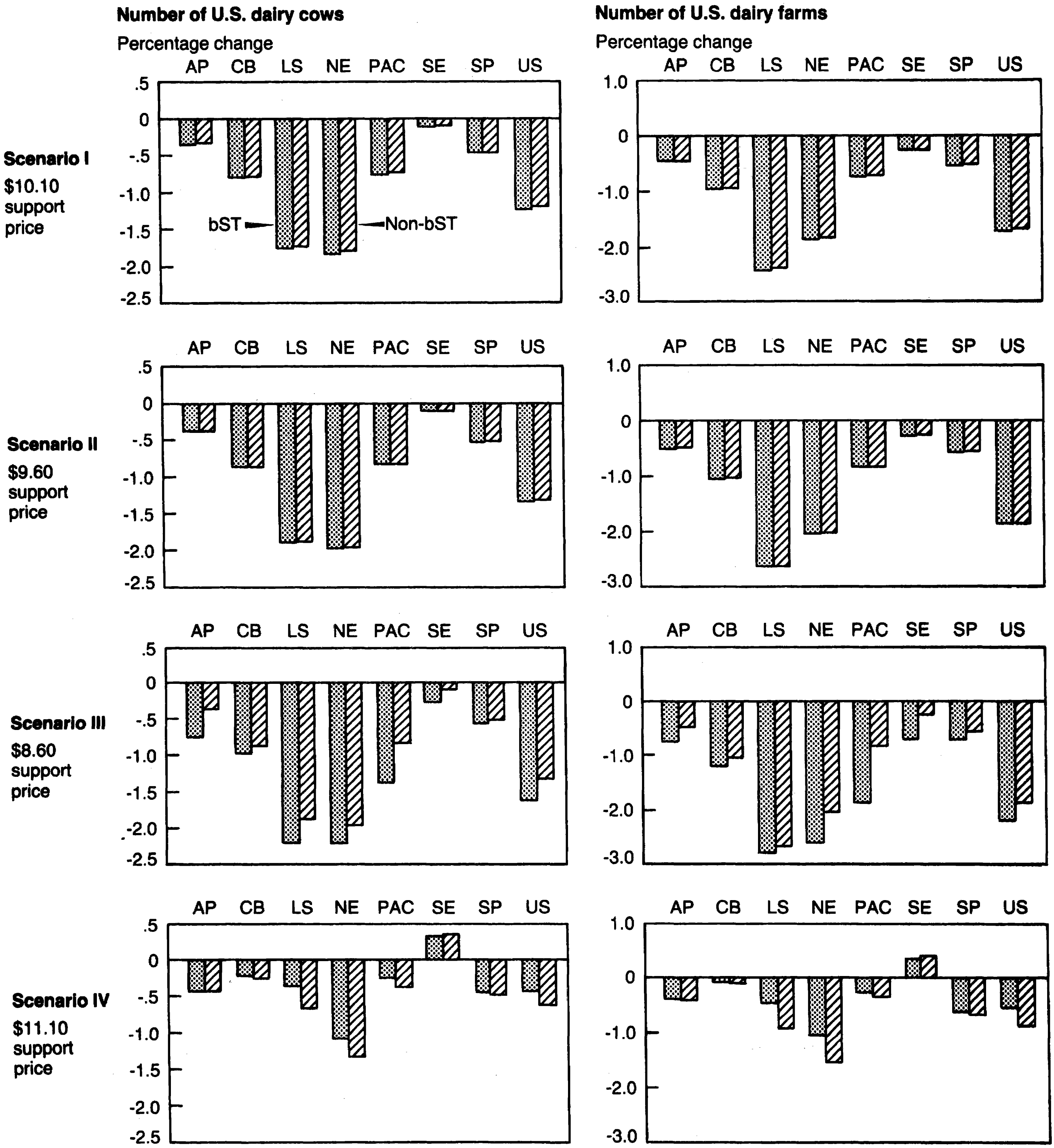
The following sections present the national economic effects and regional structural effects of the difference between bST and non-bST under four policy scenarios (fig. 4). The scenarios begin in 1990, the year we assume bST will be commercially introduced.

> *Scenario I*: With a minimum support price of $10.10, bST does not significantly affect cow numbers. The all-milk price is lower with bST, but productivity per cow rises and total production rises more than total commercial use. Thus, from 1992-96 the Government purchases approximately 8 billion more pounds of dairy products per year with bST than without it.

Scenario I places the initial all-milk price at $11.13 at the start of the analysis period because of the assumed $10.10 support price (which applies only to manufacturing-grade milk). Starting in 1990, the bST price trend and the non-bST price trend diverge as the

Figure 3

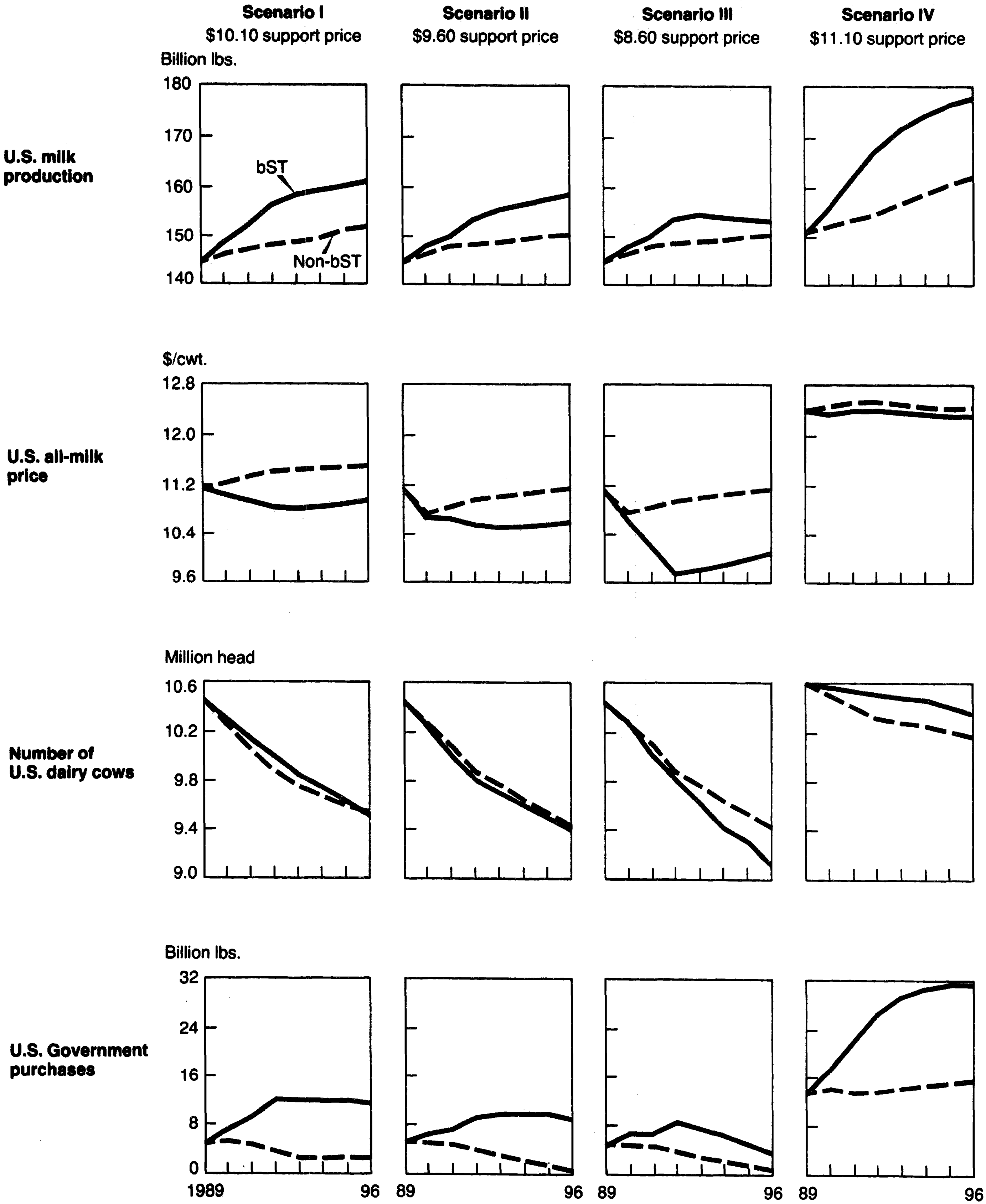
Annual average change in cow and farm numbers between 1986 and 1996 shows little difference with bST use



AP .... Appalachia
CB .... Corn Belt
LS .... Lake States
NE .... Northeast
PAC ...... Pacific
SE .... Southeast
SP .... Southern Plains
US .... United States

Figure 4

Alternative dairy policies influence the magnitude of bST's effect



non-bST price rises. The difference between the two trends increases through 1994. By 1996, the non-bST all-milk price is 55 cents higher than the bST all-milk price.

The lower bST all-milk price is largely offset by the increased productivity of bST and lower milk production costs. Thus, dairy farm profitability and the resulting cow inventory follow the same general trend with and without bST. Cow numbers are initially 10.4 million, then decline to 9.5 million in 1996. The differences between bST and the non-bST trends are not significant.

Increased cow productivity with bST results in more total U.S. milk production in 1990 and beyond. With bST, total production increases 8 percent, from 149 billion pounds in 1990 to 161 billion pounds in 1996. Without bST, production increases 4 percent to 152 billion pounds in 1996.

Commercial use is higher with bST than without because bST lowers milk prices. However, inelastic demand (a 1-percent drop in the retail price raises consumption less than 1 percent) for milk and dairy products means that the difference between the two trends is not great, amounting to 300 million pounds more commercial use of milk and dairy products by 1996.

Government purchase of surplus products increases after 1990 with bST because the increase in total production overshadows the increase in commercial use. In 1990, the Government purchases about 2 billion pounds more with bST. After 1993, this difference averages around 8 billion pounds.

> *Scenario II:* A minimum support price of $9.60 results in fewer cows both with and without bST, and an increase in Government purchases due to bST that is less than the increase under Scenario I.

The results of Scenario II are approximately the same as Scenario I except that cow numbers are lower and the increase in Government purchases is lower. Introducing bST does not significantly affect the viability of dairy farms or the change in cow numbers. Scenario II cow numbers drop about 1 percent from Scenario I numbers with or without bST. Under Scenario II, the all-milk price is 56 cents per cwt lower with bST than without by 1996, and Government purchases are almost 8 billion pounds higher.

> *Scenario III:* With the minimum support price dropping to $9.10 in 1991 and to $8.60 in 1992 with bST, more dairy farmers leave the industry. Cow numbers drop 12 percent with bST and 9 percent without bST by 1996. Milk prices drop 9 percent by 1996 with bST. With bST, Government purchases increase slightly through 1992, but then steadily decline. By 1996, Government purchases are only about 2 billion pounds higher with bST.

Scenario III provides for minimal Government intervention in the market through relatively low support prices which results in an all-milk price at approximately equilibrium levels. This equilibrium was achieved in the non-bST case without any further price support reductions from the $9.60 level in 1990. Thus, non-bST conditions under Scenario II and Scenario III were identical.

With bST, the additional milk production, hence additional price support reductions in 1991 and 1992, reduces the support price to $9.10 in 1991 and to $8.60 in 1992 through 1996. From 1992 through 1996, the all-milk price averages $1.13 per cwt lower with bST than without bST. The lower all-milk price with bST reduces cow numbers. The increased productivity of bST does not completely counteract the effect of substantially lower milk prices. Cow numbers drop 12 percent with bST and 9 percent without bST by 1996. By 1996, even with bST, Government purchases are reduced to 3 billion pounds when the support price is permitted to fall from $10.10 to $8.60.

bST use affects cow and farm numbers in Scenario III more than in other scenarios because milk prices decline more with bST than without bST. The Appalachian, Corn Belt, and Lake States regions have similar trends in cow and farm numbers with or without bST. However, cow and farm numbers drop considerably more in the Pacific, Southeast, and Southern Plains regions with bST (relative to non-bST) because these regions have many more specialized dairy farms with relatively high variable costs, relatively low fixed costs, and a lower proportion of farm income generated from other enterprises (including Government payments). Such dairy farms are thus more susceptible to severe downward milk price pressure.

> *Scenario IV:* Maintaining the support price at $11.10 assists marginal producers under financial stress and demonstrates the obvious cost of an inflexible agricultural price support program when technology is rapidly changing. By 1996, milk production increases to 178 billion pounds annually with bST, and to 162 billion pounds without bST. This increase is reflected in substantially larger Government purchases.

Scenario IV allows more financially marginal producers to stay in business by maintaining the support price at the October 1987 level of $11.10, no matter how high Government purchases climb. The all-milk price remains at approximately $12.45 with and without bST.

The increased productivity of bST coupled with constant milk prices maintains dairy farm income and thus keeps cow numbers essentially constant. The combination of increased cow productivity, yet approximately the same number of cows, boosts total U.S. milk production to 178 billion pounds by 1996 with bST. Without bST, cow numbers continue a long-term downward trend, and total production increases to 162 billion pounds in 1996, 9 percent below the bST figure.

Government purchases of surplus products to maintain the $11.10 support price are considerable and bST further exacerbates the situation. With bST, total Government purchases increase to 31 billion pounds in 1996. Without bST, purchases increase to nearly 16 billion, one-half the bST level.

The International Implications of bST

Use of bST under current international trade rules would have little effect on U.S. competitiveness in the world dairy market. Almost every major developed dairy producing country supports its dairy industry. Most subsidize part or all of domestic production. Imports are commonly restricted and exports are frequently subsidized. Thus, the international dairy market bears little resemblance to a freely operating market. Without substantial changes in international trade policies or sharply reduced U.S. dairy product prices, bST would have little effect on the U.S competitiveness in world dairy markets. But a change to a freer trade environment would put the United States at a considerable disadvantage if bST were used in competing countries but not in the United States.

Relative costs of milk production are one measure of competitiveness among countries (table 3). A 1981 study applied budgeting techniques to secondary data to assess the relative costs of producing milk in countries which exported casein to the United States. The United States has the seventh highest milk production costs of the countries studied. But, when dairy product shipping and handling charges are added to costs of production, the United States can compete in price for the U.S. market with all countries except New Zealand and Australia.

Table 3—Total cost of milk production, selected countries, 1978

Country	Cost per cwt	Index	Rank
	U.S. dollars	Average = 100	
New Zealand	4.27	58	1
Australia	5.68	77	2
Ireland	6.73	91	3
France	7.68	104	4
Argentina	7.75	105	5
West Germany	8.51	115	6
United States	8.77	119	7
Netherlands	9.78	132	8
Average	7.40	100	NA

Chapter II

Objectives

This analysis projects the performance of the dairy industry from 1990 through 1996 with and without the use of bST under four alternate price scenarios (see box on policy scenarios, Chapter I).

The analysis extends previous economic analyses of bST that were more limited in scope because they considered either individual onfarm effects of bST or the effects on the whole industry *(2, 12)*, but not both. 1/ Kalter and others point out the need for this comprehensive scope *(12)*:

> In the aggregate, as production increases due to the hormone (bST), milk prices will fall, reducing the short-term gain in farm returns. The number of dairymen and the size of the national dairy herd will, by necessity, decline as the market seeks a new equilibrium. The size of this adjustment and its timing will depend not only on the production response to bGH (bST) and the rate of adoption but on the level and scope of Government price supports. ... Farms with low debt load, good soil resources, and superior management will be better able to survive the transition.

We present preliminary estimates of the transitional effect of bST on the dairy industry. Our analysis is gauged in terms of the effects of maintaining alternative Government price support levels, the survivability of farms in different regions and with different herd sizes, debt loads, and management skills, and the ultimate restructuring of the dairy industry at a new equilibrium point.

Several studies analyzing structural changes in the dairy industry have noted a systematic trend from smaller dairy farms with integrated crop and livestock operations to larger, specialized dairy enterprises *(8, 17)*. Although the studies stop short of assessing changes in ownership organization or regional shifts, they often infer that structural revision will shift the sector from small- and medium-sized dairy farms in the North Central region and Northeast to large-scale units in the South and West.

Rapid continuing increases in milk output per cow resulting from technological and management advancements apparently contribute the most to financial and structural changes in the industry. Although the number of dairy cows and farms has declined in the last 30 years, total output has continued to expand about 2.5 percent per year, fast enough to outpace consumption growth. Milk output per cow is spurred by:

o Higher levels of concentrate feeding and improved forage quality.

o Improved dairy herd genetics, primarily through artificial breeding and progeny testing.

o Improved health practices for dairy herds.

o Improved animal production records.

o Increased capitalization.

1/ Italicized numbers in parentheses refer to items in the References section at the end of this report.

bST is one more technology in a long line of technological changes that have affected the dairy industry since 1955. The primary objective of this study is to assess the potential effects of bST on:

- o Milk supplies, milk prices, and the structure of the dairy industry.
- o The dairy price support program.
- o The international competitive position of the U.S. dairy industry.

Specific objectives include:

o Comparing the national effect of commercially adopting bST with a non-bST situation on total milk supplies, commercial use of milk and dairy products, milk prices, and Government purchases of excess dairy products under the dairy price support program.

o Estimating benefits and costs of bST on the farm for different farm sizes in different regions.

o Projecting financial conditions of dairy farms by farm size and region with and without bST for four Government policy scenarios.

o Predicting the bST-induced structural change of dairy farms by size and region.

o Assessing likely effects on the U.S. competitive position in world dairy markets if bST is commercially available in other countries but not in the United States.

Chapter III

Review of Studies

We extensively reviewed literature on bST and communicated directly with researchers at universities, in the industry, and in proprietary companies about reasonable assumptions to use in the study. 2/ These groups are researching how well bST works and its effects on animal health and feed efficiency. More definitive assumptions on the likely response to bST treatment and adoption rates on the farm can be made as this information becomes available.

REVIEW OF ECONOMIC ANALYSES

Kalter and others conducted the most complete analysis of the economic feasibility of bST use *(12)*. They reviewed the characteristics of bST known at that time (1984), estimated the costs of manufacturing the protein, estimated the profitability of bST on representative farms in the Northeast, and projected the adoption rate if bST were commercially introduced. Their conclusions form a useful point of departure for this analysis:

- o bST can be successfully manufactured at a commercially viable price.
- o bST is economically profitable for representative farms in New York, given experimental milk production responses in dairy cattle and the estimated cost of the additional feed, labor, and other variable costs.
- o Dairy farmers will find the new technology profitable to the extent that adoption will reach a level of about 75 percent within 3-4 years.

Magrath and Tauer analyzed the effect of bST on milk supply in a regional (New York) milk market *(14)*. They studied the social costs of adopting the new technology when the dairy price support program did not allow the market to clear in the face of larger supplies and lower producer costs. They concluded that bST would not be adopted nearly as widely if market forces determine the milk price. However, with the level of milk price supports assumed in their study, bST would be readily adopted, resulting in larger milk surpluses and higher Government purchases of dairy products to reach announced price support levels.

Tauer discussed the structural implications for New York dairy farmers of introducing bST *(20)*. Tauer estimated that 19.5 percent of dairy farms would cease operations because of the falling milk prices from lower support prices and the introduction of bST. Tauer noted the importance of extending the analysis to a national framework.

Aradhyula and Krog constructed a model of the U.S. dairy sector and estimated the effect of a bST-induced supply shift within the context of the Food Security Act of 1985 *(2)*. Because our analysis used a similar model developed by Westcott *(24)*, the Aradhyula and Krog results are of major interest to us. They concluded that bST would force continued reductions in the support price because of excessive Government purchases

2/ For a more detailed description of the literature we reviewed, see Jeannine M. Kenney and Richard F. Fallert, *Bovine Somatotropin (bST): A Bibliography with Selected Annotations,* Staff Report AGES870917, U.S. Dept. Agr., Econ. Res. Serv., Oct. 1987.

until the support price falls to $7.10. Cow numbers would fall from 10.71 million in 1986 to 9.97 million in 1995.

These analyses demonstrate the problems of considering a U.S. aggregate (macro) model or a farm-level (micro) model in isolation. Micromodels, focusing on representative farm analysis, do not consider the aggregate market price and demand effects of the substantial shifts in milk supply caused by a technological change like bST. Macromodels of the dairy sector have been estimated using data for periods of limited real price changes and, thus, may not predict changes induced by large price reductions. As most authors point out, synchronizing micromodels and macromodels to produce consistent estimates of industrywide supply, demand, prices, Government purchases, and structural changes at the farm level is difficult and somewhat arbitrary.

REVIEW OF bST RESEARCH

Short-term research here and abroad indicates that bST stimulates milk production without any obvious detriment to the cow or milk quality. Although low-producing cows and high-producing cows have the potential of responding equally to bST treatment, most research has been on high-producing cows. Will nongenetic factors, such as poor nutrition management, which limit milk yield per cow in certain low-yielding herds, limit response to bST? Limited field testing has not given us the answer. Using bST does not require substantial outlays of capital or readjustments to the farm organization. But its use may require additional planning for increased nutrient needs to sustain a cow's body condition and health under increased milk output. Thus, all farmers, large- and small-scale, will generally have equal access to this technology, but longer term differential effects on the two size categories may be different.

Sustained-release formulas, enabling bST to be injected periodically rather than daily, make bST even easier to administer. Also, unlike response to other yield-enhancing products, such as feed additives (in which additional milk production is seen 6 or 8 weeks after use), response to bST is visible within 3 or 4 days of injection. Farmers using testing methods and record systems, such as that of the Dairy Herd Improvement Association (DHIA), will likely be early bST adopters and also have a system of readily observing the response of individual cows to bST treatment.

Yield Response

Foreign and U.S. researchers in the public and private sectors have documented significant milk yield increases from bST use. What determines the magnitude of the response has not been defined conclusively because responses vary among research trials. Cows receiving 12.5 milligrams (mg) of bST per day for about 266 days show responses ranging from 4 added pounds of 3.5 percent fat-corrected milk (FCM) per day *(1)* to 12.6 pounds FCM *(9)*. 3/ Response to a 25-mg dose of bST, injected daily for about 266 days, ranged from 9.7 more pounds of 3.5 percent FCM *(9)* to 21.3 additional pounds *(18)*. A 50-mg bST dose yielded 9 more pounds of 3.5 percent FCM *(7)* to 19.6 additional pounds *(9)*. The largest documented increase was 23.6 pounds per day during a second lactation on bST where cows were injected daily for 266 days with 40-mg of bST *(1)*.

3/ The butterfat content of milk varies significantly among cows. A cow producing milk with high butterfat content requires more energy (feed nutrients) per cwt than one producing milk with low butterfat content. The fat-corrected-milk procedure puts all cows on an equal basis in order to determine the energy required for an individual cow to produce a pound of milk.

Early research used high-producing cows to test bST effects. Several recent studies addressed the question of how cows with average or below-average yields would respond to bST. Researchers at the University of Guelph in Ontario grouped cows by milk production potential *(13)*: low (11,000–14,300 pounds of milk), medium (14,301–17,600 pounds), and high (17,601–22,000 pounds). They found that the low and medium groups responded to bST better in absolute pounds and, therefore, on a proportional basis than the high group. The Canadian research showed that the genetic milk production potential was not significant in explaining response to bST. Therefore, cows with low or poor genetic potential for milk production should be able to respond as well to bST as cows with high genetic potential.

The response in these high-producing cows (3 more pounds of milk per day) was lower than most other research has shown. However, the 7 more pounds of milk per day in the low- and medium-producing cows indicate that low-producing cows under the same management or research experiment can respond to bST as well as high-producing cows. Furthermore, a United Kingdom study indicated that the absolute yield is the same for cows with low milk production potential as cows with high milk production potential (that is, response is independent of the yield potential of the cow) *(21)*. The response to bST apparently depends to some extent on the amount administered, with the optimal dose between 12.5 mg and 50.0 mg.

There seems to be no consensus as to whether first lactation heifers respond better, worse, or the same as older cows. One Canadian trial showed heifers responding more dramatically *(6)*, while U.S. trials have shown smaller and equal responses when compared with older cows *(9)*. In addition, a Canadian study *(13)* showed that the estimated transmitting ability (ETA) as a proxy for genetic milk production potential was not significant in explaining response to bST. Therefore, cows with low or poor genetic potential should be able to respond as well to bST as high potential animals.

Florida trials indicated that cows do respond to bST despite high heat and humidity, but to a lesser degree *(19)*. Cows in subtropical environments respond about half as well as their counterparts in less stressful environments. However, reported research under high heat and humidity consisted of 28 days of bST treatment. Longer term studies in Florida have shown responses equivalent to those in other climates, indicating that high heat and humidity may depress production in the summer, but that cows can fully respond to bST in less stressful seasons.

bST does not significantly affect cow health, according to most research. However, trials have not been completed with bST administered for more than two consecutive lactations. A University of Minnesota trial showed that cows continued to respond (4.0–23.6 more pounds of FCM per day) during the second lactation, possibly indicating that cows do not "burn out" and lose producing ability from bST use *(1)*. Many studies have monitored the status of health indicators, such as metabolic disorders, digestive and reproductive problems, mastitis, and locomotion problems. However, poor conception rates were associated with the high dose (50 mg per day) injected early in the lactation in a few trials. One United Kingdom study showed an increase in the incidence of lameness while animals were in confinement *(21)*.

Research results from one chemical company have shown the sustained-release formula to be effective *(15)*. Cows on the 84-day trial, injected once every 28 days, yielded about 8 more pounds of solids-corrected milk (SCM), indicating the practicality of commercial bST application. 4/ Some research, however, indicates that daily costs of an equivalent

4/ The same type of procedure as the FCM procedure is used for solids-corrected milk.

amount of bST over a treatment period might be higher with sustained-release injections than with daily injections. Efficacy and effects on animal health of sustained-release bST products compared with daily-injected bST products are still being researched.

Feed Intake and Ration Adjustments

Dairy cattle treated with bST apparently eat more but not until 6-9 weeks after milk yield has increased. Interaction between type of diet (complete mixed ration versus constant concentrate and unlimited roughage) and milk yield response to bST is not significant, according to research in the United Kingdom *(21)*. However, proper nutrition remains a significant factor in milk yield as well as reproductive health and physical condition. If the energy content of a ration is not adjusted and cows do not eat more, they lose energy. Therefore, rations must be carefully formulated to meet the added nutrient demands required for the extra milk production from bST use. One Canadian trial attributed an increase in reproductive problems (lower pregnancy rate and increased number of cysts) to inadequate nutrition *(7)*.

Because bST increases milk output, feed rations must be adjusted to meet the added nutrient requirements. The average commercial farmer's capability to formulate adequate feed rations for cows on bST could become a key factor affecting both response to bST and longer term herd health.

Administering bST

bST cannot be administered as a feed additive because it is broken down into its constituent amino acids by the digestion process. Therefore, it must be injected into the cow to be effective. A short, fine needle (1/2-inch, 20-gauge) can be used because the quantity of material injected is small. Researchers report that cow reaction to the injections is minimal. In addition, they have not reported any irritation or bad reaction at the injection site. These results from the daily-injection testing certainly would hold for the periodic, sustained-release injections.

Privately funded research has indicated that a farmer can store dehydrated bST in a small refrigerator on the farm and rehydrate it with sterile saline solution when needed. A typical syringe gun can hold enough bST solution to inject 25 cows before reloading. Even more elaborate, costly dispensing mechanisms are already used in the animal industry to administer drugs. Each injection takes only a few seconds. Prep time is estimated to take about 15 minutes to mix ingredients sufficient to treat an entire herd.

The sustained-release formula could relieve the burden of daily injections. It, too, would be injected, but only periodically (possibly at 7-, 14-, or 28-day intervals). Regardless of frequency of injection, a veterinarian is not required, and the process is simple enough to make every producer a potential user.

Chapter IV

Methodology

The study team drew the methodology for this study from various sources:

o Extensive meetings with researchers in Government, universities, and the private sector to critique the various aspects of bST use and research.

o An informal Delphi process (a technique of eliciting the technical knowledge and opinions of experts and developing a consensus) and an extensive survey of the literature to arrive at the yield assumptions and adoption rates used in this study (see Chapter V for a detailed explanation).

o Two computer models to provide insights into the operation of the sector and to develop simulations for evaluating alternative adoption/nonadoption scenarios.

o Extensive USDA, university, and industry review of study background material, assumptions, and methodology.

o Our own judgment and internal USDA review in evaluating model output to ensure realistic results.

THE MODELS

We used two models to quantify the likely effects of bST use. A macroeconomic (dairy industry) model looks at the whole dairy industry and explains milk supply, demand, prices, and Government purchases at the national level. A set of microeconomic (farm-level) models explains the financial operations of "typical" dairy farms by region, size, productivity, and financial health.

Linking the two models helps to consistently tie national policy assumptions and supply, demand, and price results to adjustments on individual farms, and vice versa. The link between the models, working through adjustments in milk prices and cow numbers, is critical because it generates consistent equilibrium estimates of milk supply, demand, price, Government costs, and structural indicators, such as the number and size of dairy farms by region. The models interact through five consecutive steps:

o The dairy industry model predicts the national all-milk (farm-level) price, milk production, commercial use, and Government purchases with and without bST for the four price support scenarios.

o The farm-level model uses the national milk price projections from the industry model to analyze the viability of a broad cross-section of dairy operations, representing most commercial U.S. dairy farms. The model assumes that nonviable farms exit from the industry, leaving 35 percent of their most productive dairy cows and associated capital to new farms with characteristics representative of farms with higher, more viable rates of return on their capital investment.

o We applied statistical expansion factors to project the results of the farm-level model to estimate the number of farms in a particular region with similar characteristics. (Expansion factors are statistical estimates of the number of U.S. farms based on region, farm size, productivity, and financial health.) We aggregated these results for all farm types in a region to arrive at cow numbers and the number of farms that remain in and exit from operation over the 10-year period. We aggregated the regions to estimate the national number of farms and cows expected to continue or cease production.

o We checked the results of the farm-level model for consistency with the industry model's prediction of cow numbers. If a disparity existed between the two models, we adjusted the cow numbers of the industry model to equal the aggregated results of the farm-level model and developed a new price regime (see fig. 2).

o This process continued until the cow numbers and price scenarios from both models were simultaneously consistent with each other.

The Dairy Industry Model

We used the Quarterly Model of the U.S. Dairy Sector, developed by Westcott (*24*), to simulate operation of the U.S. dairy economy with and without bST for the four policy scenarios. The quarterly model is a nine-equation, aggregate model of the U.S dairy sector, consisting of four behavioral equations, representing milk cow inventories, milk production per cow, commercial milk use, and farm milk price. The behavioral equations act simultaneously as either a direct or indirect result of the farm-level price of milk which, in turn, is a function of the support price. The aggregate model is, therefore, sensitive to changes in the milk support price. The remaining equations are all identities, with net Government purchases being the market-clearing equation.

We modified the original model in the following ways (see table 4 for the equations of the modified model):

o Included 1981-86 data to estimate the model coefficients. During this period, real prices fell but output per cow continued to rise. The result is that the coefficients of milk production per cow are less sensitive to price and reflect long-term productivity growth.

o Accounted for the effects of the Dairy Diversion and Dairy Termination programs.

o Provided for adjustments in equation 1 so that cow numbers would match the farm-level model predictions.

o Used a multiplicative factor to adjust milk production per cow for the introduction of bST.

The Farm-level Model

We developed a farm-level model to project net worth (total assets minus liabilities) of representative dairy farms. The farm-level model is a series of linked simulation models that represent major dairy farm types based on region, farm size in terms of cow numbers, productivity in terms of yield per cow, and financial health in terms of debt/asset ratios (the fraction of total farm liabilities to total farm assets).

The simulation models describe the financial operation of the representative farms by tracing through receipts, expenses, assets, equity, capital outlays, and financing. In the simplest terms, the models simulate cash flow and calculate net worth to monitor the viability of the representative farms. If an operator's net worth falls to zero because of cumulative income losses, asset depreciation, or erosion in equity due to borrowing, the operator is assumed to become bankrupt and leave the sector. Otherwise, the farm is assumed to continue operating. The model assumes no internal growth in capacity for

Table 4—Quarterly aggregate dairy industry model with bST 1/

Variable		Equation	
Milk cow inventory	COWKM	= 0.997COWKMt-1 + 24.84MIPEFFt-1 − 23.42FDPFMt-1 (448.06) (5.26) (−3.31) − 2.18CAPFM − 50.27D1 − 32.25D2 − 215.54WHB (−2.68) (−3.61) (−2.41) (26.43)	(1)
	R^2	= 0.997	
Milk production per cow	MISPRPC	= 1,215.65 + 0.412MISPRPCt-4 + 0.042MIPEFFt-1 (4.25) (0.01) − 0.414SMPDMt-1 + 37.02G1 + 32.98D1 + 189.17D2 (−3.94) (5.85) (2.45) (5.39) + 78.11D3 − 77.71D75 − 88.32D1V (17.44) (−4.17) (−5.09)	(2)
	R^2	= 0.989	
Milk production	MISPR	= (COWKM * MISPRPC)/1,000	(3)
Milk marketings	MISMRK	= MISPR − MIUFR	(4)
Total milk supply	MISST	= MISMRK + MICITC + MISMT	(5)
Commercial milk use	MIUCM	= 22,545.96 − 75,987.00(MIPFM/CPI) + 1,253.37(Y/CPI) (−5.71) (10.94) + 116.78D2 * TA + 178.15D3 * TA + 143.28D4 * TA (8.26) (12.56) (10.46)	(6)
	R^2	= 0.935	
Net Government milk removals	MICGVN	= MISST − MIUCM − MICOTC	(7)
Farm milk price	MIPFM	= 1.254 + (0.979D1 + 0.930D2 + 0.887D3 + 0.927D4) MIPSP (45.57) (34.37) (33.72) (39.18) − 0.205 (MISPR/1,000) + 0.234 (MIUCM/1,000) (6.33) (4.81)	(8)
	R^2	= 0.988	
Effective milk price	MIPEFF	= MIPFM − MIPDED	(9)

See footnotes at end of table.

Continued--

Table 4—Quarterly aggregate dairy industry model with bST 1/--Continued

Variable	Definition	Unit
CAPFM	Beef cattle farm price	Dollars per cwt
COWKM	Milk cow inventory	Thousand head
CPI	Consumer Price Index	1967 = 100
Di	Dummy variable equal to 1 in the ith quarter; i = 1, 2, 3, 4	NA
DIV	Dummy variable equal to 1 if in a quarter of Dairy Diversion Program	do.
D75	Dummy variable equal to 1 in 1975	do.
FDPFM	Feed price 2/	Dollars per cwt
GI	Genetic improvement proxy-annual trend equal to 1 in 1966	NA
MICGVN	Net Government milk removals	Million lbs 3/
MICITC	Beginning commercial milk stocks	do.
MICOTC	Ending commercial milk stocks	do.
MIPDED	Milk price deduction	Dollars per cwt
MIPEFF	Effective milk price	do.
MIPFM	Milk farm price	do.
MIPSP	Support price for milk	do.
MISMRK	Milk marketings	Million lbs
MISMT	Milk imports	do. 3/
MISPR	Milk production	do.
MISPRPC	Milk production per cow	Lbs
MISST	Total commercial milk supplies	Million lbs
MIUCM	Commercial disappearance of milk	do.
MIUFR	Farm use of milk	do.
SMPDM	Soybean meal price, Decatur, 44-percent protein	Dollars per ton
TA	Annual trend equal to 1 in 1966	NA
WHB	Dummy variable equal to 1 if in a quarter of Dairy Termination Program	do. do.
Y	Nominal personal disposable income	Billion dollars

NA = Not applicable.
1/ The t-statistic is reported in parentheses below each coefficient.
2/ Weighted average of corn price and soybean meal price.
3/ Milk equivalent of products, milkfat basis.

individual farms, except through trend increases in milk yields under the non-bST scenario, accelerated trend growth under the bST scenario, and the addition of cows and capital from exiting farms. The model is constructed in nominal dollars with parameters for inflation, separate milk and feed prices, and interest rates. We used statistical expansion factors to project the results from a particular category of farms and, thus, give a picture of structural change for the whole sector.

Components of the Farm-level Model

We constructed the model as a series of interrelated components on a microcomputer spreadsheet (fig. 5). (See Appendix I for a full description.) The major components of the simulation models are herd dynamics; capital outlays, capital financing, and operating loans; net cash flows; operating revenues and expenses; and tax liabilities.

Herd dynamics. This component simulates the age distribution, original purchase, and final disposition of all livestock over time. The model divides the herd into four groups: purchased cows, raised cows, replacement calves and heifers, and bulls and bull calves. The model further subdivides purchased cows, raised cows, and replacement calves and heifers into age brackets to determine the age distribution of the herd. We exogenously entered into the model for the four groups the culling, infertility, and death rates, which control both herd dynamics and the ratio of purchased to raised cattle in the herd.

Capital outlays, capital financing, and operating loans. The model calculates an annual schedule of capital outlays for facilities and livestock over the simulation period:

- o Equipment is replaced at the end of its economic life.

- o The herd dynamics equations determine livestock purchases needed to maintain herd size.

- o Machinery outlays are financed using constant principal loans with specified downpayment percentages.

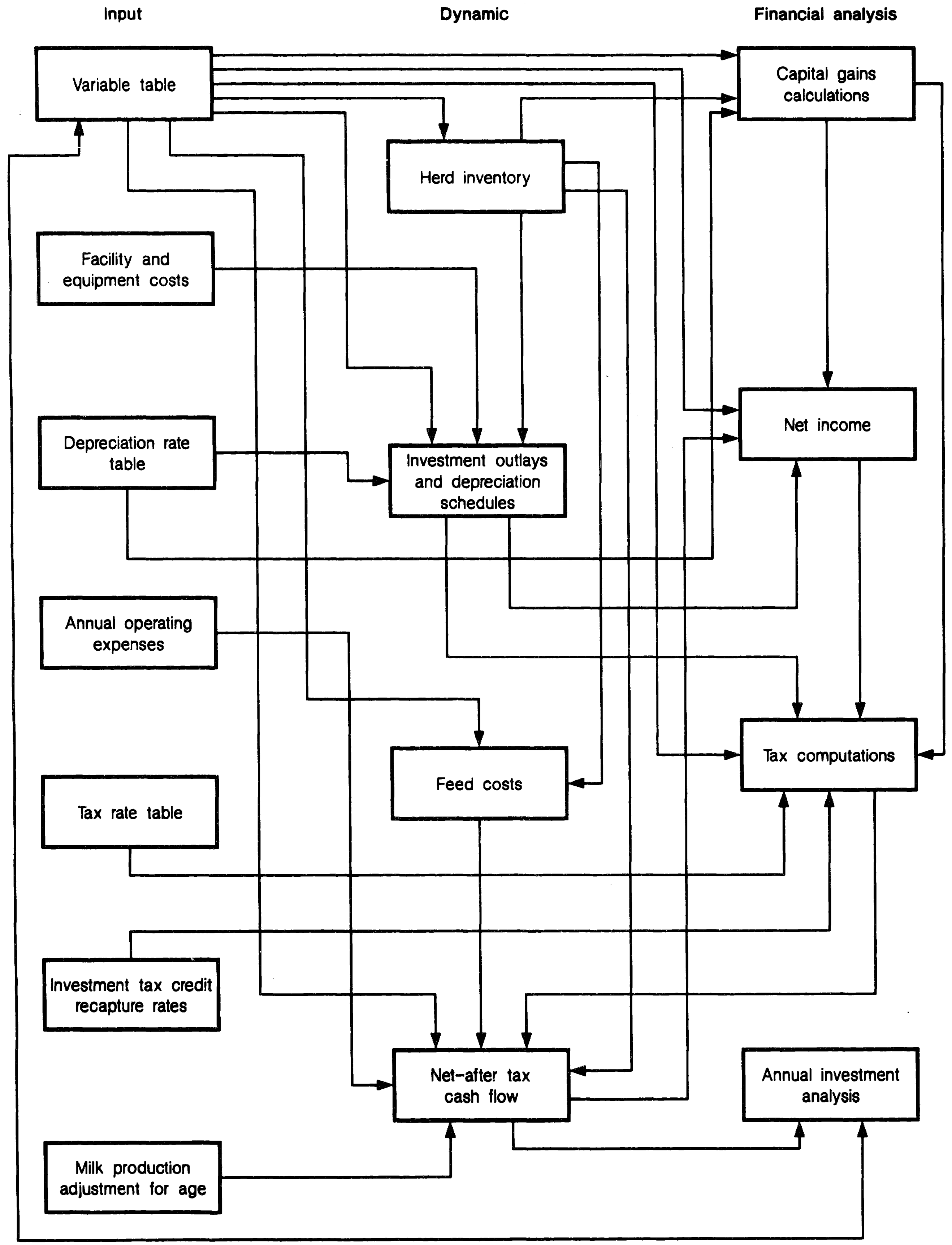
- o If the cash flow from accumulated earnings and net operating receipts is insufficient for capital financing and family living expenses, short-term operating loans are assumed to cover the deficit.

Because the model has no internal decision apparatus, a low return on equity results in deteriorating net worth when replacement machinery is financed. Thus, the model may understate the number and pace of exits of financially stressed farms. At least part of the sector's capital base moves when returns become uncompetitive, not necessarily waiting for negative rates to erode equity. The model alternatively does not incorporate changes in farm operation or in mix of enterprises to cope with deteriorating net worth.

Net cash flow. The model assumes that the retained-earnings account earns the discount rate. The model subtracts family living expenses from the account and adds after-tax outside income. The model assumes that family living expenses are 50 percent of annual cash flow after capital expenditures. However, there is a minimum withdrawal of $6,500 and maximum of $34,000. These amounts correspond to family expenses in the 1985 New York Farm Business Survey. If the farm does not have sufficient cash flow for the minimum $6,500 personal withdrawals, short-term operating loans provide additional funds.

Operating revenues and expenses. Cash operating receipts include returns from the sale of milk, livestock, and salvaged equipment. Exogenous indexes adjust the prices of all products. The industry model determines the price of milk. Annual production of the

Figure 5
Simulation model for the dairy farm sector



herd depends on the milk equivalent, which is adjusted for genetic improvement, the presence of bST, and the herd's age distribution. Production changes systematically over the useful life of the dairy cow *(3)*. National Holstein production records provide the age factors. The production capability of the herd increases at a specified rate of genetic improvement; U.S. dairy herds have historically increased at an annual average of 240 pounds of milk per cow. The model assumes that bST increases annual production an additional 1,800 pounds per cow for all herds using bST because evidence is inconclusive on bST's effectiveness on different herds and/or production levels (Chapter III). Other cash receipts include number of animals sold, which is from the herd dynamics equations. Cash inflows are net price received for each animal category times the number of sales.

Cash expenditures consist of feed costs, labor, utilities, fuel, property taxes and insurance, repairs, supplies, miscellaneous expenses, veterinary breeding costs, cattle hauling, and bST expenses. The model estimates labor, DHIA, veterinary, breeding, and miscellaneous expenses as a per-cow cost times herd size. Utility and milk-hauling costs are a function of the cwt of milk produced. Insurance, repairs, supplies, accounting, and property taxes are constant expenses over the planning horizon, adjusted for inflation. The cost of bST is the per-treatment amount administered seven times during the latter portion of the lactation cycle.

The model calculates feed cost--the major variable cost of a dairy operation--based on production levels, the number and age distribution of animals, and prices for forage and concentrates, assuming a 16-percent protein ration. The feed energy value of the forage and the level of milk production for a 305-day milking cycle determines forage and concentrate consumption per cow. We integrated an allowance for the variability of forage quality into the feed cost calculation. Data for feed consumption and the forage-to-concentrate ratios were obtained from Hubrik and others (*11*). The model allocates the variable cost of crop production for vertically integrated dairy farms between forage and concentrates based on forage-to-concentrate ratios. The model automatically adjusts feed intake and forage-to-concentrate ratios for increased production from bST use.

Tax liabilities. The dairy simulation model incorporates the provisions of the 1986 Tax Reform Act, which eliminates capital gains, changes depreciation to the depreciation schedules of the Tax Reform Act, and makes other extensive changes. The model's tax computations follow the same sequence as Form 1040 of the Internal Revenue Service.

Projecting Net Worth

The farm's net worth can follow several conceptual paths:

- Net returns to capital are insufficient to pay interest on capital liabilities. Thus, net worth deteriorates as operating loans steadily increase when the dairy farm replaces machinery.

- Income is sufficient to pay for capital, interest charges, and minimum personal withdrawals. Thus, net worth steadily increases.

- Net profits exceed interest on capital and maximum personal withdrawals. Thus, net worth exponentially increases as the retained-earnings account increases at a faster rate relative to other liabilities and assets.

Representative Farms Used in the Farm-level Model

We used USDA's Farm Costs and Returns Survey (FCRS) to characterize farms according to size within each of the major regions. Figure 6 illustrates farm size distribution within the Pacific region. From this distribution, we defined three frequency intervals of representative farm types in the Pacific region: farms with 1–249 cows and a mean size of 126 cows, 250–499 cows and a mean size of 298 cows, and 500 or more cows and a mean size of 1,221 cows. We constructed size distributions and defined representative farm types for the other regions in the same way.

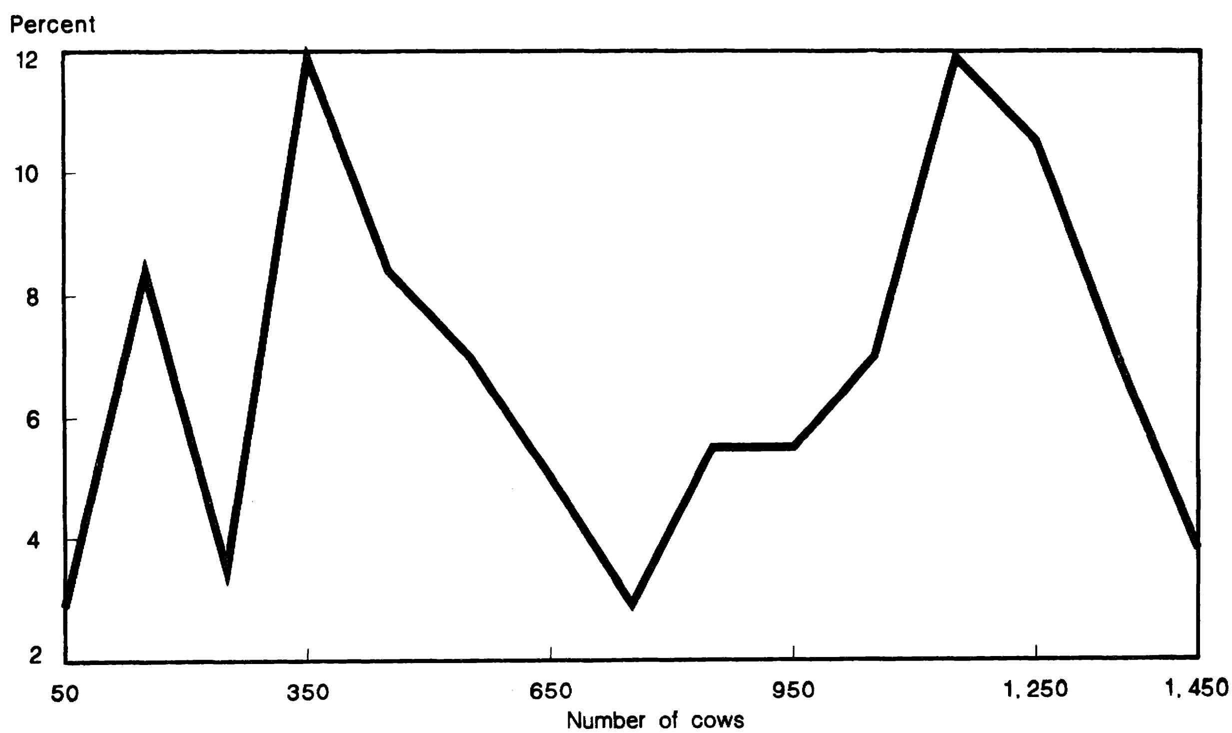
We averaged FCRS observations of farms within the frequency intervals to arrive at operating costs, total farm assets, and nondairy sources of income (crop sales and off-farm income). We used several representative farm sizes for the Lake States, Northeast, Southeast, Southern Plains, Corn Belt, Appalachia, and Pacific regions. Then, we further classified them by level of milk production per cow and debt/asset ratios.

Aggregating the Farm-level Modeling Results

The pace of structural change is reflected in the number of farms that the farm-level model projects will go out of business, adjusted by expansion factors to calculate cow numbers, number of farms by size categories, and total production in each region. If, for example, the farm-level model indicates that a 50-cow farm in the Lake States with milk production of 12,000 pounds per cow and a 40-percent debt level will become insolvent in 1990, then the number of similar farms identified by the FCRS are assumed to cease operation. The change in total regional production and structure is an aggregate of exit rates by all representative farms.

To assume that all productive assets associated with a bankruptcy will be completely retired from milk production is unrealistic. We assumed that 35 percent of the milking herd of an insolvent farm would be allocated to farms with the highest after-tax rates of return on capital in that region. If no farms in the region have at least an 8-percent after-tax nominal rate of return on capital, the cows are allocated to the nearest region with farms realizing such a competitive rate of return. Thus, total cow numbers within a

Figure 6
Distribution of dairy cows in the Pacific region by herd size



region were reduced by 65 percent of the number of cows on farms forced into bankruptcy. The remaining 35 percent were reallocated to new farms with characteristics of representative farms with the highest rate of return on capital.

Adjustment of Industry Model Supply

Aggregating regional cow numbers from the farm-level model provides an estimate of national cow numbers for comparing consistency between the industry model and the farm-level model. If they were inconsistent, we adjusted the industry model cow numbers to match cow numbers from the aggregated farm-level model results. We then reran the industry model with the new cow numbers to produce a new national milk supply, demand, and price scenario. We incorporated the new price scenario into the farm-level model and repeated the regional analysis. This iterative process continued until the price scenarios and cow numbers were consistent.

Results and Limitations of the Models

This methodology is a compromise between two different conceptual frameworks of industry behavior. The industry model uses aggregate statistical estimates to predict the general behavior of the industry based on historical trends. Because the dairy industry was expanding in 1970-83, the model may not be well suited for predicting industry behavior and structure when the industry is contracting or when milk supplies substantially shift because of new technology like bST.

The farm-level model predicts farm survival based on cash flow, net worth, and bankruptcy rules. The model does not allow farms to adjust their enterprises in the face of adverse economic conditions (short of bankruptcy when net worth drops to zero). It would be logical for a farm to stop operation, modify the mix of crop and livestock enterprises, or use facilities, equipment, and family resources more intensely before bankruptcy, thus preserving, to some extent, owner equity. These options were not considered. Thus, the farm-level model may overstate the bankruptcy rates of farms. However, the model probably underestimates the pace of structural change short of bankruptcy. Furthermore, it does not predict exits from the industry due to other reasons, such as retirement.

Another limitation of the methodology is the effect of regional supply adjustments on Class I utilization in different Federal orders, and thus, the effects on regional all-milk prices. The model incorporates 1986 regional all-milk price differences and holds these differences constant over the period of the simulation.

Chapter V

Data Sources and Assumptions

The farm-level model and industry model require data on farm characteristics, feed, price projections, and assumptions about the adoption of bST and its effect on national- and farm-level yield. In addition, Government dairy policy significantly influences the effect of bST adoption.

The analysis depends on general economic conditions assumed to be in effect over the projection period. Assumptions about income growth, interest rates, national income, and consumer purchases of milk and dairy products are particularly important and are subject to the general caveats applied to long-term projections. To simplify the analysis, we assumed that these economic performance indicators would continue on recent trends over the 1990-96 projection period. We did not try to analyze foreign trade policy or alternative macroeconomic conditions that could significantly change conditions.

MAJOR ASSUMPTIONS

Chapter I presents the major assumptions used in this study on bST approval and production timeframe, yield response, the adoption rate, bST costs, feed use, and effects on animal health and reproduction. Here are a few additional points on the major assumptions.

Yield Response

Our assumption that annual production increases 1,800 pounds per bST-treated cow (about 8.4 pounds per day for a 215-day period) no matter what baseline production level is used represents an overall average effect because many experts suspect response differences given differing management styles. We also assumed that seven monthly sustained-release injections are administered once a month during the lactation cycle, beginning around 90 days post partum.

It is not definite whether response is proportional to the cow's pretreatment production level or if the response is an absolute quantity independent of the cow's previous production level or production potential. Even though intuition may suggest a proportional response, most research indicates that the absolute response used in this study is appropriate. Actual response will vary from farm to farm, but there are no data that quantify this variability. Thus, we assumed that region or operation size do not affect response.

Adoption Rate

The adoption rates used in this study are based on literature review, results of model farm simulations, and an extensive review of our previous and higher adoption rate by nearly 100 researchers and industry representatives. Most of these experts indicated that the lesser rates of adoption used in this study (see Chapter 1) are more realistic.

Feeding Adjustment

We assumed that the same level of nutrients per pound of milk are required to produce the additional milk generated by bST as without bST. We adjusted the feed to account for the rise in total digestible nutrients (TDN) and crude protein (CP) required to produce the additional milk.

In the costs and returns analysis, National Research Council data on nutrient requirements of dairy cattle show that a dairy cow needs 0.304 pounds of TDN and 0.082 pounds of CP to produce 1 pound of 3.5 percent FCM *(16)*. We assumed the dairy concentrate feed to supply 0.180 pounds of CP and 0.765 pounds of TDN per pound of concentrate. We added to the feed ration the amount of concentrate needed to supply the protein required to produce the additional milk. We calculated the amount of TDN supplied in excess of the cow's needs by the additional concentrate. We reduced the amount of hay in the feed ration by an amount equivalent in TDN to this excess TDN. We assumed hay to have 0.620 pounds of TDN per pound of hay. This method increases the nutrient densities of the rations without exceeding the cow's intake capacity.

Labor

We assumed a monthly sustained-release product given in seven treatments over 215 days. The amount of additional labor required for the injections and the increased, if any, milking time at the higher production levels has not been quantified in the research done to date. We assumed the extra labor required in this analysis to be 0.32 hours per cow.

Limitations of the Major Assumptions

Several of the assumptions are open to question. In addition to the effect of climate on yield response (see Chapters I and III), production efficiency and acceptance can affect bST adoption. A large percentage of dairy farmers apparently operate at less than maximum economic and production efficiency *(5)*. Whether these farmers will adjust production practices, particularly feeding and herd health procedures, to the new production levels is not known. If farmers do not make the necessary adjustments for increased milk production levels from bST, long-term production responses may be negative, possibly causing some producers to stop using bST, at least on some cows, and slowing the acceptance rate among other producers. Some commercial farmers milk their cows three times a day, a practice that under poor management sometimes causes stress on the cows, resulting in nutritional, herd health, and other managment-related problems. Some researchers suggest that the problems associated with milking three times a day may also occur with bST use. Furthermore, some researchers claim that the health risks to the cow are great enough to discourage some farmers from using bST. Such problems would reduce the profitability of bST use, especially among operators lacking top management skills. However, others indicate that health changes in the cow from bST are very minimal, if any.

Bulk tank capacity, feed storage facilities, or other farm resources may constrain early adoption *(20)*. Dairy farmers have rarely adopted new technology instantly (for example, artificial insemination and DHIA recordkeeping have not been adopted by all farmers). Only two innovations (mechanical milking machines and bulk tanks) have been adopted by a high percentage of dairy farmers. Handlers may refuse to accept milk from producers using bST, fearing adverse consumer reaction. Certain State milk orders and dairy cooperatives impose production bases or quotas on members. With quotas, different management practices are required to gain the economic benefit from bST, although a farm operating under a production quota may still increase profits using bST.

Incorporating factors that are not yet understood but that might affect adoption and/or yield response to bST by different farm types is beyond the scope of this study. Researchers disagree over bST's projected effects. The conclusions that can be drawn from short-term, closely managed trials with small numbers of cows are limited in predicting bST's effects over the entire lactation, multiple lactations, and on all cows under actual farm conditions. However, all representative farm categories are assumed to respond similarly in terms of adoption rate and yield response to bST in this analysis.

DAIRY FARM CHARACTERISTICS

Dairy farms vary in structural characteristics from small, integrated (multiple-enterprise) units to large, single-enterprise drylots primarily in the South and West. The drylots of the South and West tend to purchase all feeds, use only hired labor, and market only milk, cull cows, and calves *(8)*. Integrated operations in the Lake States and Northeast grow feed (especially forage) onfarm, use unpaid family labor, and often receive other sources of income, both farm and off-farm. Because the farm-level model represents all types of dairy farms, we assumed the following to adapt the farm-level model to the diversity of dairy farm structures:

o Variable crop expenses (seed, fertilizer, and fuel) for integrated farms are those associated only with forage production, which remains relatively constant as milk production per cow increases. The quantity of forage purchases as presented in the FCRS also remains constant over the simulation period.

o Feed purchases for integrated farms consist of concentrates and grains, with the volume purchased tied to fixed milk-to-feed ratios and average production per cow. We mathematically expressed prices of concentrates and grains so that the farm-level model's total feed costs would match average FCRS feed costs for similar farms. The quantity of concentrates and grains purchased increases according to positive changes in milk production per cow whether due to genetic improvement or bST injections. Therefore, feed costs then increase or decrease according to exogenous feed price changes from USDA's *Agricultural Prices: 1985 Summary (23)* and milk production per cow levels.

o Large drylot operations generally buy all concentrates and forages needed. We adjusted prices of both so that feed costs in the farm-level model match representative FCRS farm data for 1985. We then used production and price indexes to determine feed costs for subsequent years the same as we did for integrated farms.

These assumptions ensure that integrated farms are as capable of expanding milk production as single-enterprise drylot operations and that fixed farm resources, such as land, do not constrain milk production because any additional feed required is assumed to be purchased.

THE FARM-LEVEL MODEL

The primary data source for the farm-level model was the 1985 FCRS for dairy farms, which is representative of commercial U.S. dairy operations. We used the survey to determine representative farm sizes (see Chapter IV); average operating costs for each size group (excluding depreciation, capital outlays, interest charges, and income taxes); land, building, and machinery assets; other sources of revenue and income besides the sale of milk; and expansion factors for each representative farm. We also used *Agricultural Prices: 1985 Summary (23)* for the all-milk price by region. We used a costs and returns analysis to estimate the likely market price of bST assuming a 2-to-1 net return. We used the resulting 24-cent cost estimate per treated cow per day in all simulations.

Financial Calculations

The farm-level model replaces depreciable capital assets during the period of analysis. Because the major factor determining the viability of a particular dairy farm is return on invested capital, we considered the cost and financing of replacement capital in detail. To ensure a conservative estimate of machinery replacement costs, we assumed the following:

o Farmers will replace machinery and equipment in 1990, 1992, and 1995 at book-value costs (adjusted for inflation). This assumption is based on FCRS estimates of the 1985 book value of machinery and equipment for each representative farm. We subdivided this estimate into equal assets with useful life expectancies of 5, 7, and 10 years. This procedure is conservative because current equipment is already used but assumed in the analysis to have the useful life of new equipment.

o Machinery and equipment are financed with 7-year constant principal loans at 11-percent interest. A downpayment of 20 percent is required from accumulated earnings. All farms raise replacement cattle. The Tax Reform Act of 1986 requires that costs associated with replacement cattle be treated as capital outlays, not as cash expenses. Other assumptions concerning raised replacements (a 33-percent culling rate, a 3-percent death rate for cows, a 5-percent death rate for youngstock, and a useful life of 5 years for production cows) were constant for all representative farms.

o Farms maintain a retained-earnings account that returns 8 percent on accumulated savings. The retained earnings pay for capital outlays. If earnings are insufficient, a short-term operating loan with an interest charge of 12 percent is extended to cover cash-flow deficits. In years of surplus retained earnings, the operating loan debt is retired as much as possible.

o The farm-level model also incorporates a 4-percent inflation rate into nonfeed operating costs, machinery, and land values.

Operating Revenues and Other Sources of Income

The farm-level model endogenously determines operating revenues from the sale of milk and cull livestock. Initial prices for milk, calves, cull cows, and replacements are from *Agricultural Prices: 1985 Summary* (23). The herd dynamic component of the farm-level model determines cull cow and calf sales. We adjusted prices for these beef products with an index based on projected cattle prices. The industry model determines national all-milk prices. Each representative farm also had a milk price differential (the difference between the regional price, from FCRS, and the national all-milk price in 1985). We assumed this differential to remain constant over the projection period.

Representative farms in the Midwest receive considerable revenue and Government payments from crop sales and programs. The farm-level model uses crop price indexes to project the revenue from these sources. We assumed production quantities and off-farm income, included in the cash flow section of the model, to remain constant in real terms.

THE DAIRY INDUSTRY MODEL

We assumed the following about the external price and policy variables for the dairy industry model:

o The Consumer Price Index increases 4 percent per year. Personal disposable income for consumers increases 5.5 percent per year in nominal terms.

o Private inventories of milk products and net exports do not change from 1986 levels.

PRODUCER COSTS AND RETURNS

In addition to the linked models, we used USDA's 1986 regional COP (cost of production) framework to establish the profitability of onfarm bST use and to estimate a market cost for bST. Costs and returns on a per-cow basis and a per-cwt basis for six regions and the United States at five levels of production response to bST (3, 5, 10, 20, and 30 pounds per day) are presented in Appendix II. The COP data do not represent an individual or specific producer. Instead, they are statistical averages of all dairy farms in the various regions and in the United States. Therefore, costs and returns of individual producers vary greatly within regions because the mix of inputs, management skills, and milk production yields differ. Furthermore, the COP analysis does not incorporate milk price changes resulting from bST adoption. The COP is only a partial analysis based on 1986 economic conditions used in conjunction with our other methodology.

Costs

We assumed that the quantity of feed required per cow increased as milk output per cow increased. We then used the market prices for feed and labor from the 1986 regional COP budgets to value the additional feed and labor required to use bST. We assumed that milk hauling, milk marketing, and dairy assessment costs are charged on a per-cwt basis. Therefore, these costs on a per-cow basis will change according to the new production levels.

We assumed all other costs not previously discussed to remain constant on a per-cow basis, regardless of whether bST is used or not. We calculated all the per-cwt costs by dividing the per-cow costs by the new production levels, excluding milk hauling, marketing, and assessment charges.

bST Break-even Cost

The break-even cost is the maximum amount that could be paid for bST to break even with the non-bST level of return. It is the difference between cash returns per cow (cash receipts less cash expenses and capital replacement charges) with and without bST. We calculated the break-even cost per treatment by dividing this margin by seven treatments.

Break-even Milk Price

We calculated the break-even milk price by subtracting the margin for bST purchase on a per-cwt basis from the current milk price. We did not assume any cost for bST because data on the likely market price of bST are not available. Our "break-even" method of analysis isolated the effects of bST by allowing the regions to remain at the same level of returns as they were before using bST. We also calculated a "true" break-even milk price by subtracting the value of cull cows, calves, and replacements from the total economic costs in each region. Total economic costs exclude actual interest payments but include allocated returns to owned inputs. The economic costs allow comparisons of costs between regions without regard to equity or tenure. This "true" break-even estimate does not account for previous levels of returns.

Chapter VI

Effects of bST on Producer Costs and Returns

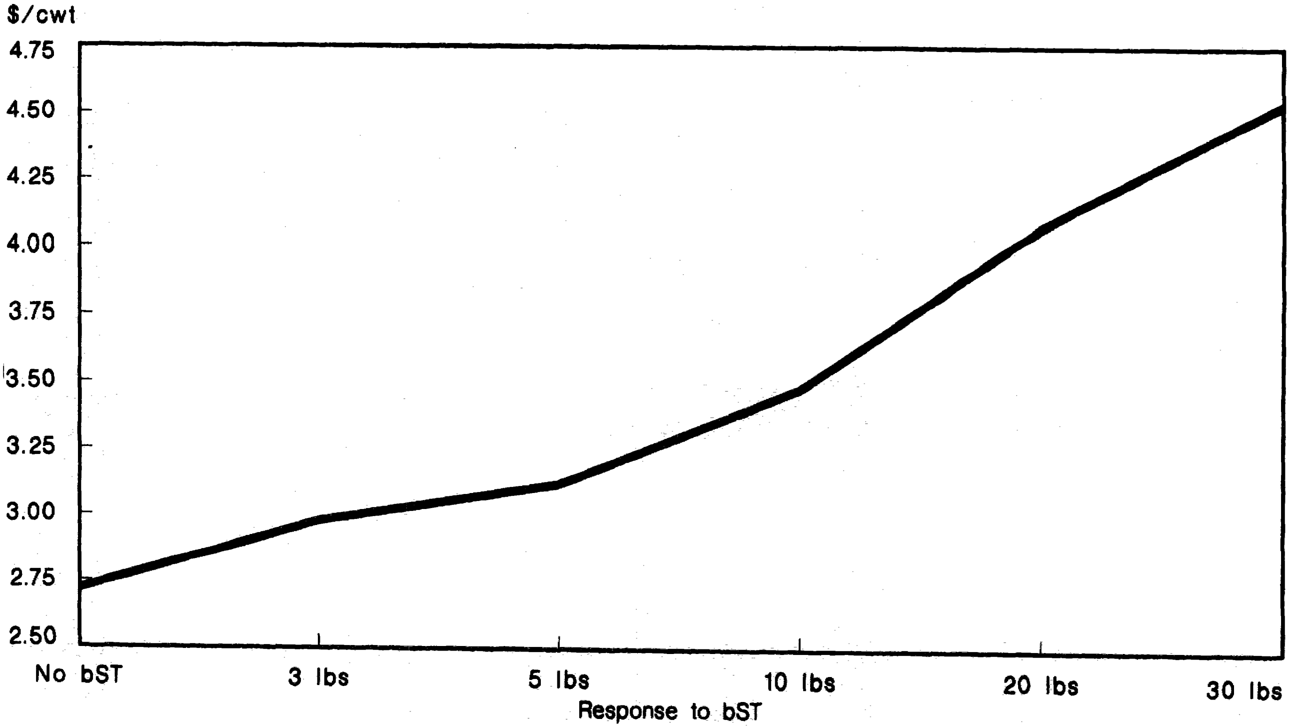
Response to bST will vary substantially among individual farms and cows. However, under the 1986 U.S. average all-milk price ($12.52 per cwt), bST generally increases net returns with as little as a 3-pound-per-day response level as long as it costs less than $8 per monthly treatment. If bST costs as much as $16 per monthly treatment per cow, then responses greater than 5 pounds per day are needed for profitable bST use. If bST costs $8 per treatment, responses of 5 pounds per day remain profitable even with milk prices of $9.10 per cwt. With responses of 10 pounds per day, bST increases net returns with milk prices below $8.60 per cwt. At a bST cost of $4 per treatment, returns increase with as little as a 3-pound-per-day response level, even with milk prices as low as $8.60 per cwt.

Average net returns in 1986 are negative without bST if the milk price falls to $10.10 per cwt. If producers can purchase bST for $8 per treatment, net returns for an average producer become positive when response is above 10 pounds per day. Below this response rate, net returns are negative even with bST use, but they are less negative than without bST use. Furthermore, if response to bST is close to 20 pounds per day and bST costs $8 per treatment, net returns are positive with milk prices as low as $9.60 per cwt.

See Chapter I for a summary of the effects of bST on producer costs and returns and Appendix II for further detail. Figure 7 shows the U.S. cash margin per cwt for bST expense and profit according to the 3-, 5-, 10-, 20-, and 30-pound-per-day response levels.

The 1986 base levels (that is, the non-bST levels) of milk production per cow differ among regions. Average annual output per cow was highest in the Pacific region at 17,698

Figure 7
Cash margin per hundredweight of U.S. milk production



pounds and lowest in the Lake States at 13,861 pounds. These regional levels of milk production per cow are slightly higher than for the U.S. average because FCRS data used in COP analyses are from commercial dairy farms specializing in milk production. The U.S. average milk production per cow figure in 1986 of 13,293 is the average of all farms with milk cows, some farms having fewer than five cows. Thus, although we assume that responses to bST are absolute (that is, the same pounds per cow in all regions), the percentage increase in milk produced per lactation differs among regions. At the 10-pound-per-day response level, output per cow increases 15.5 percent in the Lake States and 12.1 percent in the Pacific region. Using a proportional increase rather than an absolute increase has a different regional effect. The absolute increase assumption puts regions and farms with relatively low milk production per cow in a more favorable situation than those with relatively high production per cow.

CASH RETURNS

Cash returns per cow under the 1986 conditions rise the most in the Southern Plains, followed by the Lake States and Northeast, while returns in the Corn Belt improve the least. Cash returns per cwt improve the least due to bST in the Pacific region. The change in returns across regions differs $11 per cow at the 3-pound-per-day response level ($52 in the Corn Belt to $63 in the Southern Plains). The change in returns widens to $66 per cow at the 20-pound-per-day response level ($358 in the Corn Belt to $424 in the Southern Plains).

Levels of returns among regions remain in the same relative position to each other with bST as without bST. At all levels of response, residual to management and risk (total receipts minus total economic costs) per cwt is highest in the Southern Plains and lowest in the Corn Belt.

BREAK-EVEN COSTS

The break-even cost per treatment varies among regions (fig. 8). At the 3-pound-per-day response level, the Southern Plains could pay up to $8.99 per monthly treatment per cow, while the Corn Belt could pay up to $7.38 per treatment.

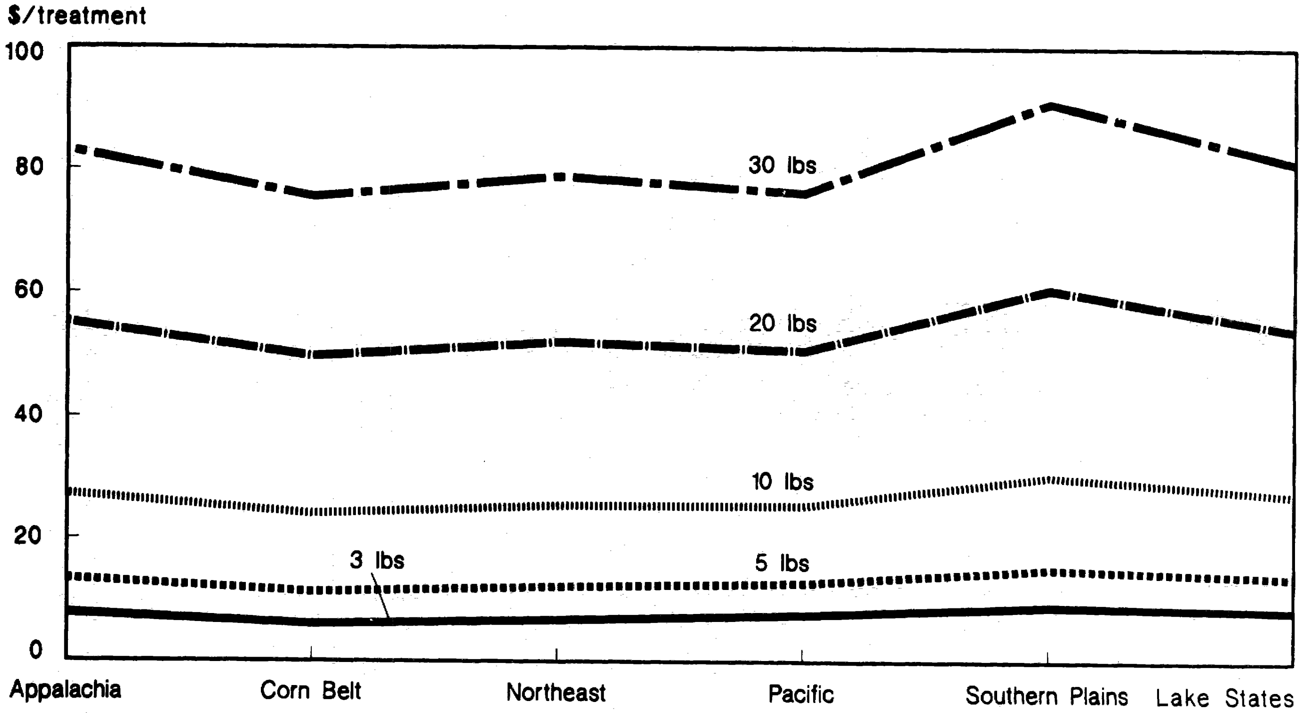
The break-even cost per treatment is highest in the Southern Plains, followed by the Lake States, indicating that these regions can profitably pay the highest price for bST at all response levels. The break-even cost at all response levels is lowest in the Corn Belt and second lowest in the Pacific region. Manufacturers of bST may price bST so that it will yield a net return to farmers of $2 for every $1 invested. Under 1986 conditions and at the 10-pound-per-day response level, the U.S. price that leaves a net return of $2 per cwt of milk produced is $8.93 per monthly treatment. Returns among regions differ. For example, the Southern Plains clears $2.38 per $1 invested; the Pacific region, $1.83; and the Corn Belt, $1.84.

The break-even cost per monthly treatment for the average U.S. producer ranges from $8.12 at the 3-pound-per-day response level to $53.57 at the 20-pound-per-day response level. Preliminary estimates from Cornell University indicate that 1 gram of bST will cost agricultural chemical companies from $1.97 to $4.23 to produce *(12)*. Assuming the highest dosage used in research for the sustained-release formula (960 mg), bST may cost between $1.89 to $4.06 per monthly treatment for the pharmaceutical companies to produce. Although these cost estimates for bST do not include an allowance for research, development, marketing, or profit, under 1986 milk production costs and returns conditions, bST is clearly a commercially viable and marketable product at as little as a 3-pound-per-day response level (fig. 8).

Use of bST remains economical even when concentrate costs are increased 15 percent to simulate higher feed costs like those of the early 1980's. The margin for bST expense on a per-cwt basis does not change from the scenario with 1986 prices. If bST use requires more veterinary and related services, a 50-percent increase in veterinary and medicine expenses reduces the margin for bST expense about 10 cents per cwt of milk. However, the break-even cost per treatment indicates that bST may still be marketable at the 3-pound-per-day response level, even if veterinary and medicine expenses increase 50 percent.

Figure 8

Break-even cost per bST treatment by milk production response levels[1]



1/ Seven treatments annually.

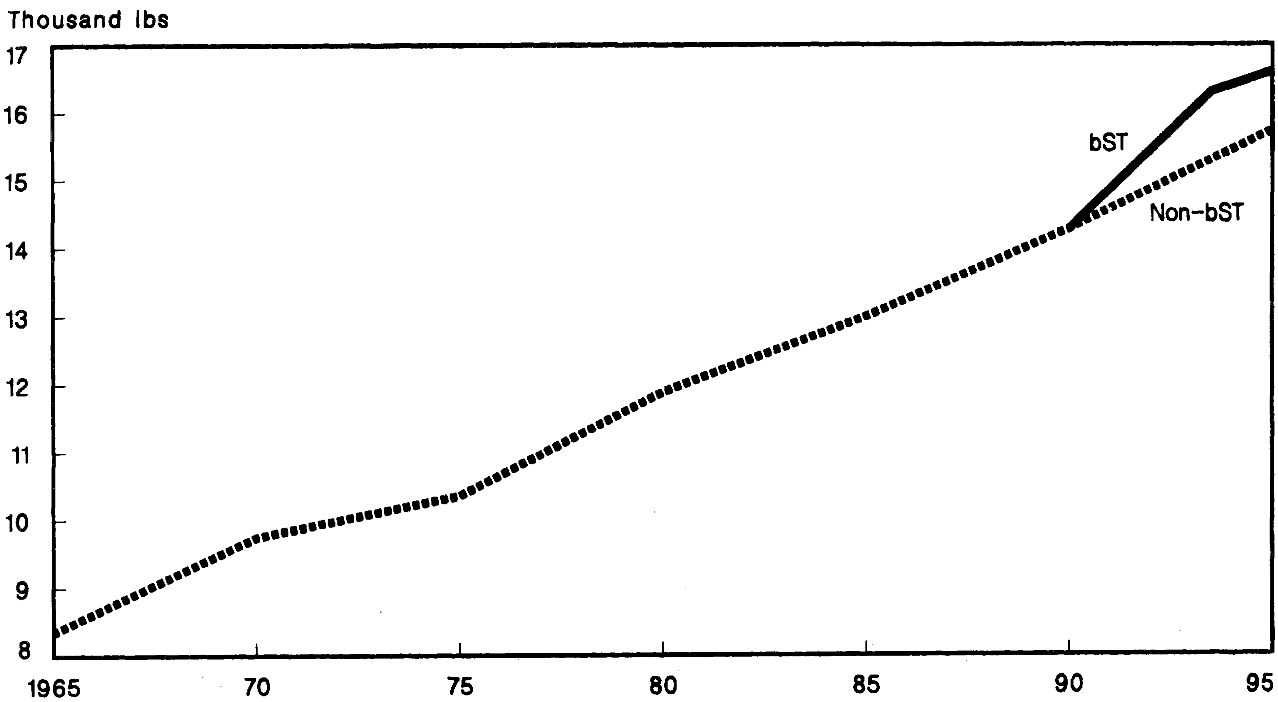
Chapter VII

National Implications of bST

The magnitude of bST's effects varies depending on which price support policy is used. The results illustrate the need for a flexible dairy program to accommodate such cost-reducing milk supply shifters as bST. Introduction of bST would accelerate increases in dairy cow productivity during the bST adoption period. The added (differential) rise in milk production per cow would continue and then parallel long-term trends that generally reflect improvements in genetics and management and higher rates of concentrate feeding (fig. 9). By 1993, the difference in production levels between the bST and non-bST trends ranges from 778 pounds (Scenario III) to 1,125 pounds (Scenario IV), after which the difference between the bST and non-bST production-per-cow levels remains essentially constant for all scenarios.

Total milk supply depends on the interaction of milk output per cow and the number of cows producing milk. With bST, output per cow rises but falling milk prices cause more cows to be removed from production. Therefore, bST's overall effect on total production heavily depends on the milk support price level. The U.S. milk supply increases 2-5 percent annually over 1990-92 relative to the non-bST trend, depending on the support price. By 1993, the Nation's milk supply ranges from 3.5 percent (Scenario III) to 10 percent (Scenario IV) higher than the non-bST level. With bST, the cost-reducing effects of bST for farmers is offset by reductions ranging from about 10 cents (Scenario IV) to $1 (Scenario III) per cwt in the all-milk price. Due to inelastic demand for milk and dairy products, bST does not significantly affect commercial milk and dairy product use, despite the reduction in the all-milk price under all scenarios.

Figure 9
Long-term U.S. milk production per cow, with and without bST[1]



1/ 1985-95 is estimated, assuming $10.10 minimum support price through 1996.

The major difference between bST and non-bST projections is the amount of Government purchases. The level of Government purchases partially reflects the balance or imbalance between supply and demand. Thus, the price support policy in effect will significantly influence the magnitude of Government purchases, with or without bST. With a minimum support price between \$9.60 (Scenario II) and \$10.10 per cwt (Scenario I), bST increases Government purchases about 8 billion pounds annually in 1993 and beyond. Scenario III allows the dairy support price to adjust over time so that production and commercial use are approximately in balance by 1996 even with bST. Government purchases fall below 5 billion pounds even with bST after 1994 in Scenario III. With Scenario IV's high support levels (\$11.10 per cwt), Government purchases with bST rise 16 billion pounds over the non-bST level by 1996.

This chapter presents the national implications of adopting bST on milk supply, commercial use, the all-milk price, and Government purchases under the price support program and compares the four scenarios with and without bST. We present the differing effects of bST under plausible dairy policy scenarios without indicating which policy scenario is most likely or desirable.

SCENARIO I

This scenario assumes a support price for manufacturing-grade milk of \$10.10 per cwt in 1990 when bST is introduced. No further adjustments are allowed through 1996.

Use of bST does not significantly affect the decline in cow numbers (see Appendix III). Although the bST trend for milk price is lower than the non-bST trend, productivity per cow is higher and U.S. production rises more than total commercial use. Thus, from 1992-96, the Government purchases approximately 8 billion pounds more dairy products per year with bST than without it.

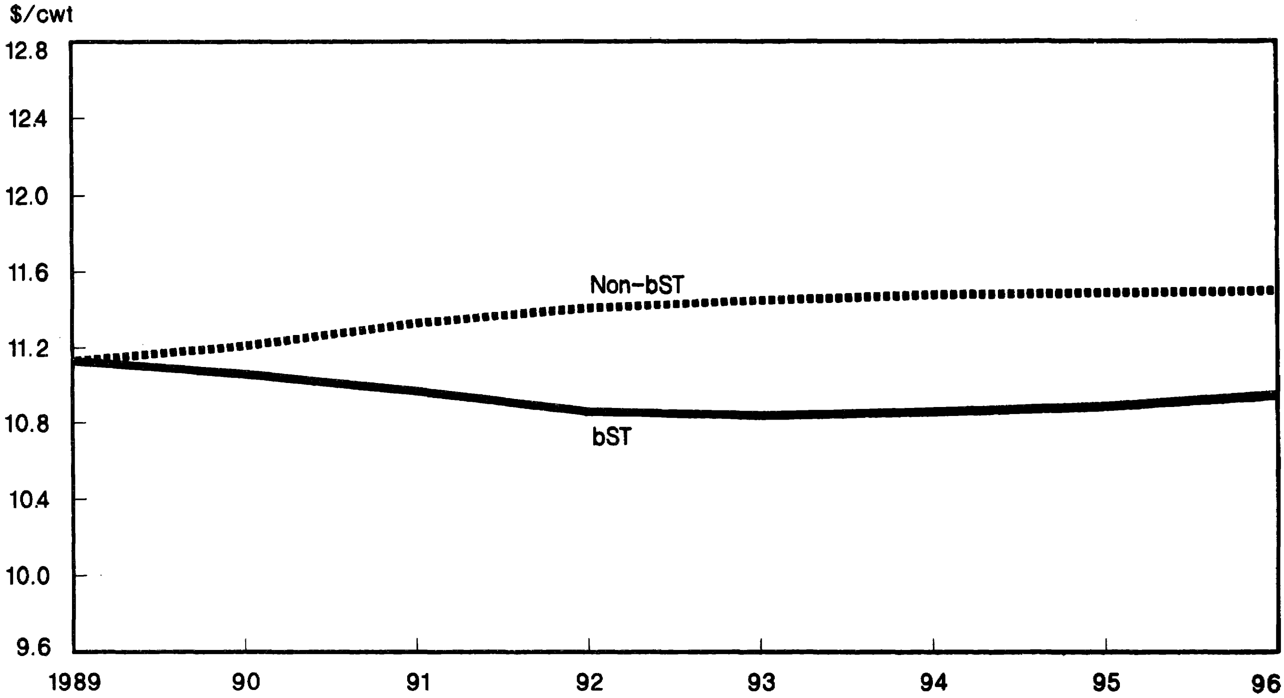
All-milk price: The initial all-milk price is \$11.13, which is above the minimum support price, primarily because of the higher returns to Grade A milk producers associated with fluid milk markets (fig. 10). The price trends diverge in 1990 with a higher non-bST price. The difference between the two price trends increases to 61 cents by 1993 and then remains near that level through 1996. The all-milk price is lower with bST because increased supplies reduce the proportion of fluid milk use relative to manufacturing milk use in Federal orders. The all-milk price reflects the average price received by farmers, weighted by the percentage of their milk that goes into higher valued fluid use and lower valued manufacturing use.

Cow numbers: The difference between the bST and non-bST trends is not significant (fig. 11). With bST, increased productivity, lower milk production costs, and profitability of onfarm use (see Chapter VI) largely mitigates the effect of lower milk prices. Dairy farm profitability and the resulting cow numbers follow the same general trend with and without bST. Cow numbers, initially 10.4 million, drop to about 9.5 million in 1996.

Total milk production: With bST, milk production rises 8 percent in 1990-96 to 160.5 billion pounds (fig. 12). The non-bST trend rises 4 percent from 146.5 billion pounds to 152.0 billion pounds.

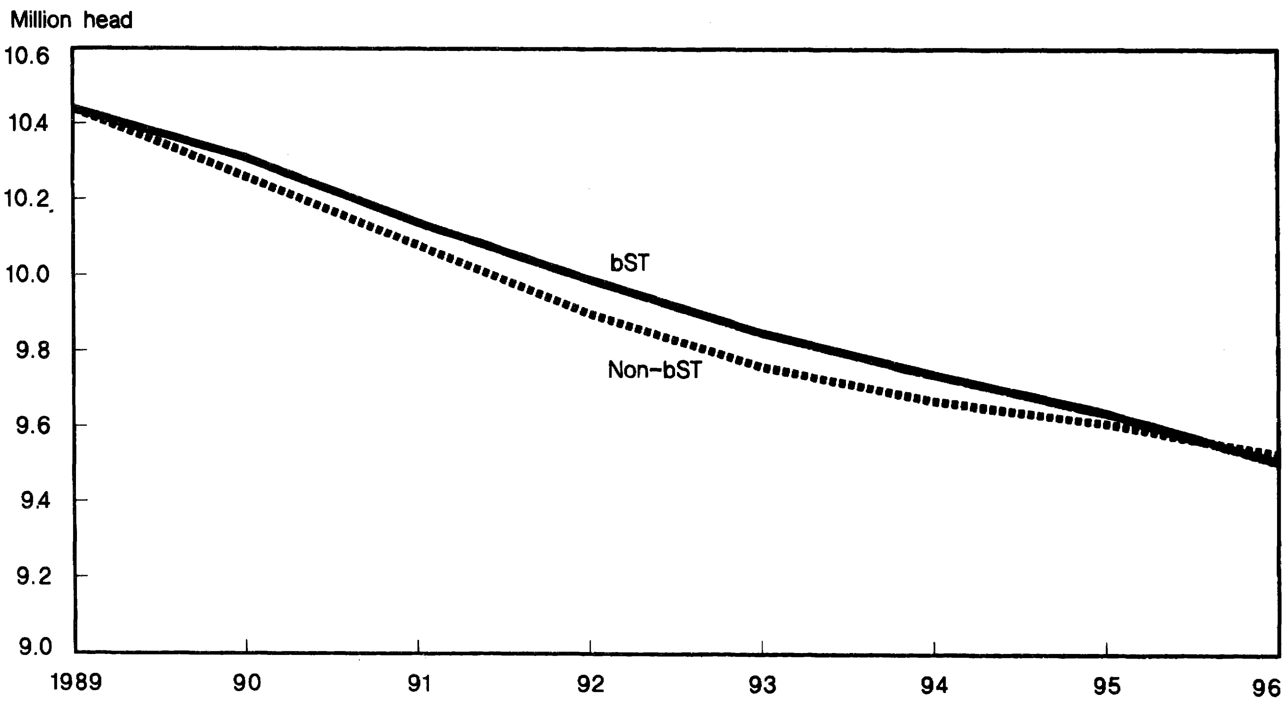
Commercial milk and dairy product use: The lower milk price with bST raises commercial use (disappearance) over that without bST (fig. 13). However, because of inelastic demand (a 1-percent reduction in consumer prices results in a less than 1-percent increase in consumption) for milk and dairy products, the difference

Figure 10
Scenario I: U.S. all-milk price[1]



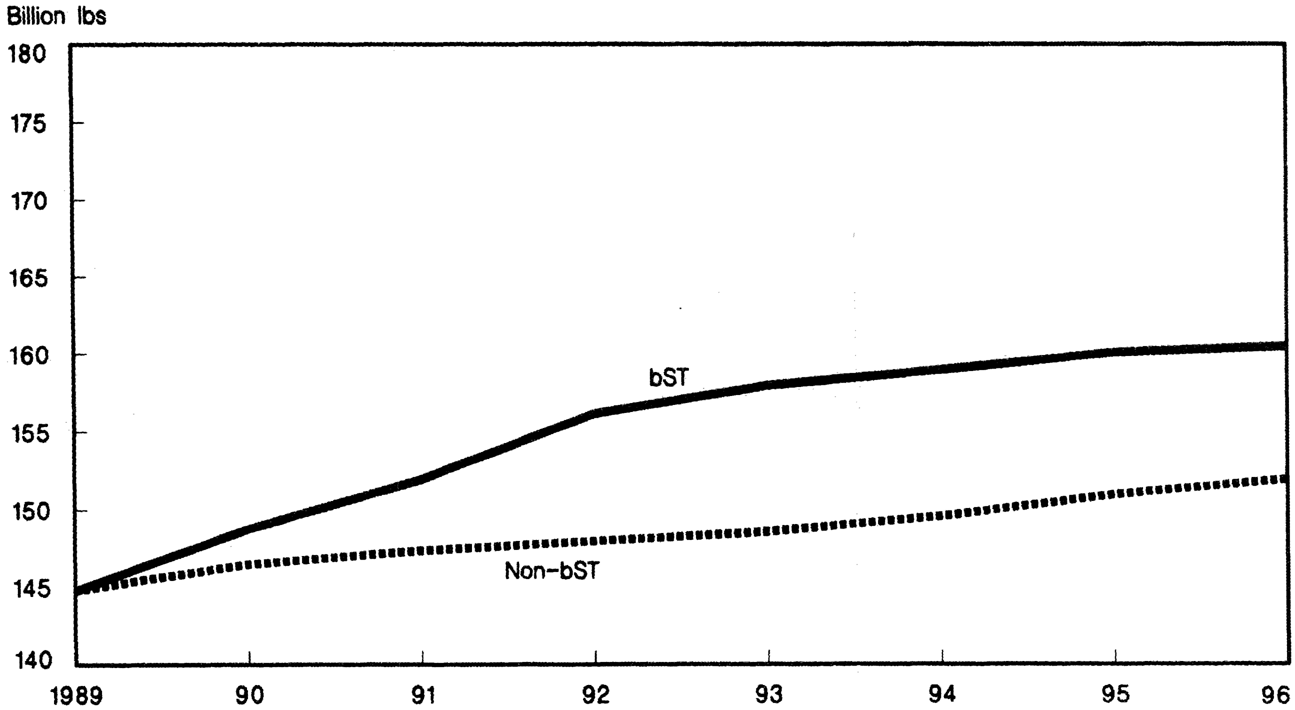
1/ Minimum $10.10 support price.

Figure 11
Scenario I: Number of U.S. dairy cows[1]



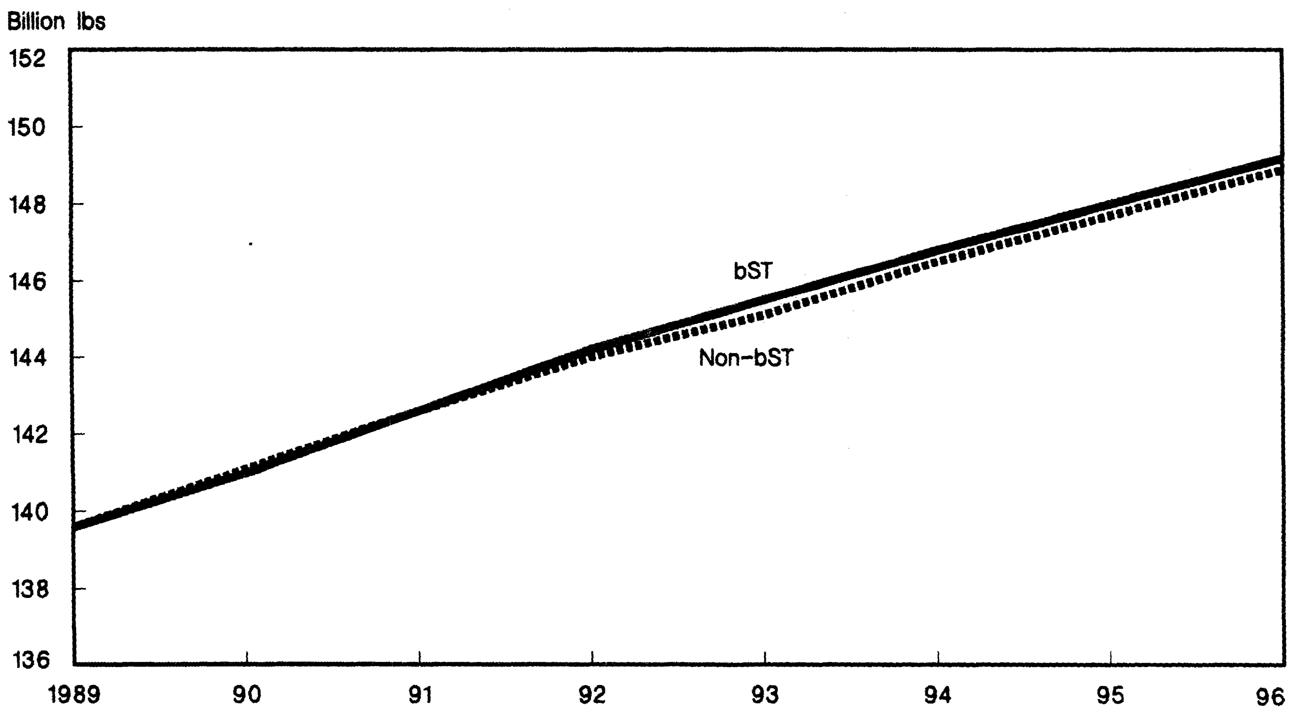
1/ Minimum $10.10 support price.

Figure 12
Scenario I: U.S. milk production[1]



1/ Minimum $10.10 support price.

Figure 13
Scenario I: U.S. commercial disappearance[1]



1/ Minimum $10.10 support price.

between the two trends is not significant. The bST increase amounts to about 300 million pounds more commercial use of milk and dairy products by 1996 than without bST.

Government purchases: The bST trend in Government purchases rises because of the larger increase in total production combined with approximately equal commercial disappearance (fig. 14). The difference between the two trends increases from about 2 billion pounds in 1990 to about 9 billion pounds in 1993. This difference then declines slightly to about 8 billion pounds in 1996 as the drop in cow numbers slows the rate of increase in total production with bST.

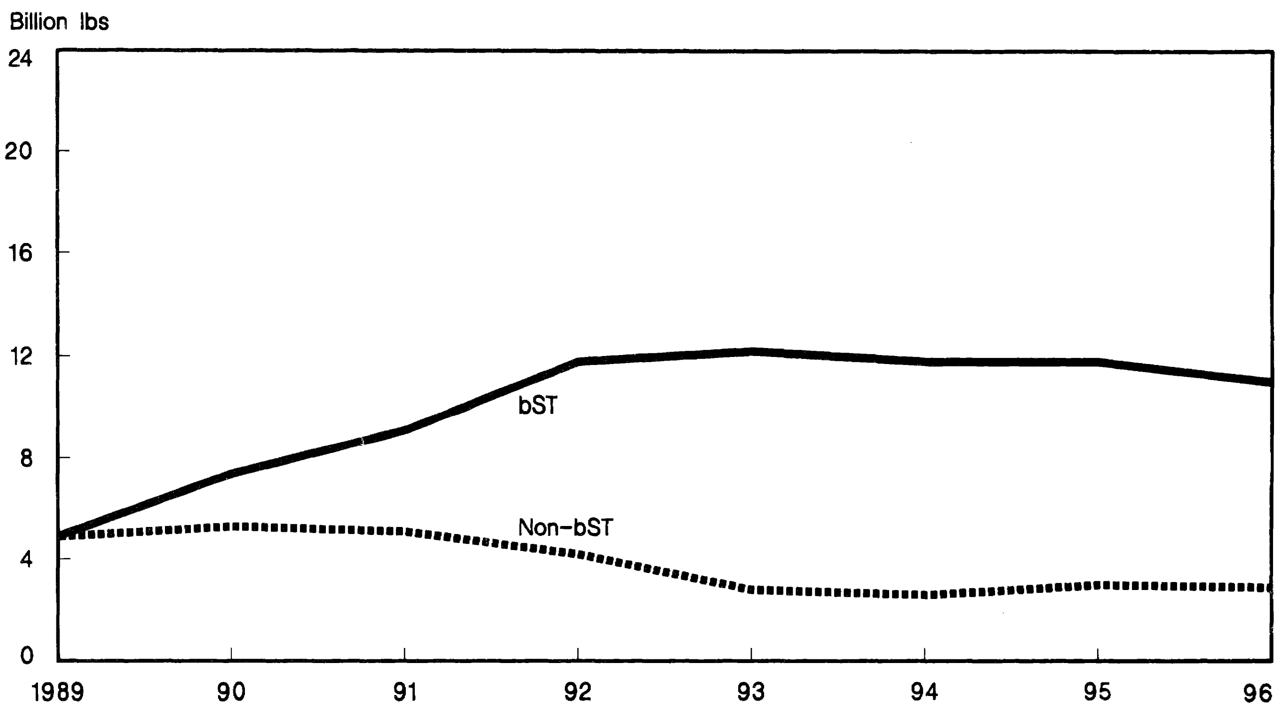
SCENARIO II

This scenario assumes a support price of $9.60 by 1990 when bST is introduced. This figure is the statutory price reduction limit of the Food Security Act of 1985. No further changes in the support price are allowed through 1996.

The results of Scenario II are similar to those of Scenario I, except that there are fewer cows with and without bST, leading to lower total milk production and, thus, lower Government purchases (see Appendix III). Again, the introduction of bST itself does not significantly affect the viability of dairy farms or the change in cow numbers.

All-milk price: The difference between the two price trends is similar to Scenario I, increasing until 1992 and then remaining about constant through 1996 (fig. 15). By 1996, the all-milk price is 56 cents per cwt lower with bST than without.

Figure 14
Scenario I: U.S. Government purchases[1]



1/ Minimum $10.10 support price.

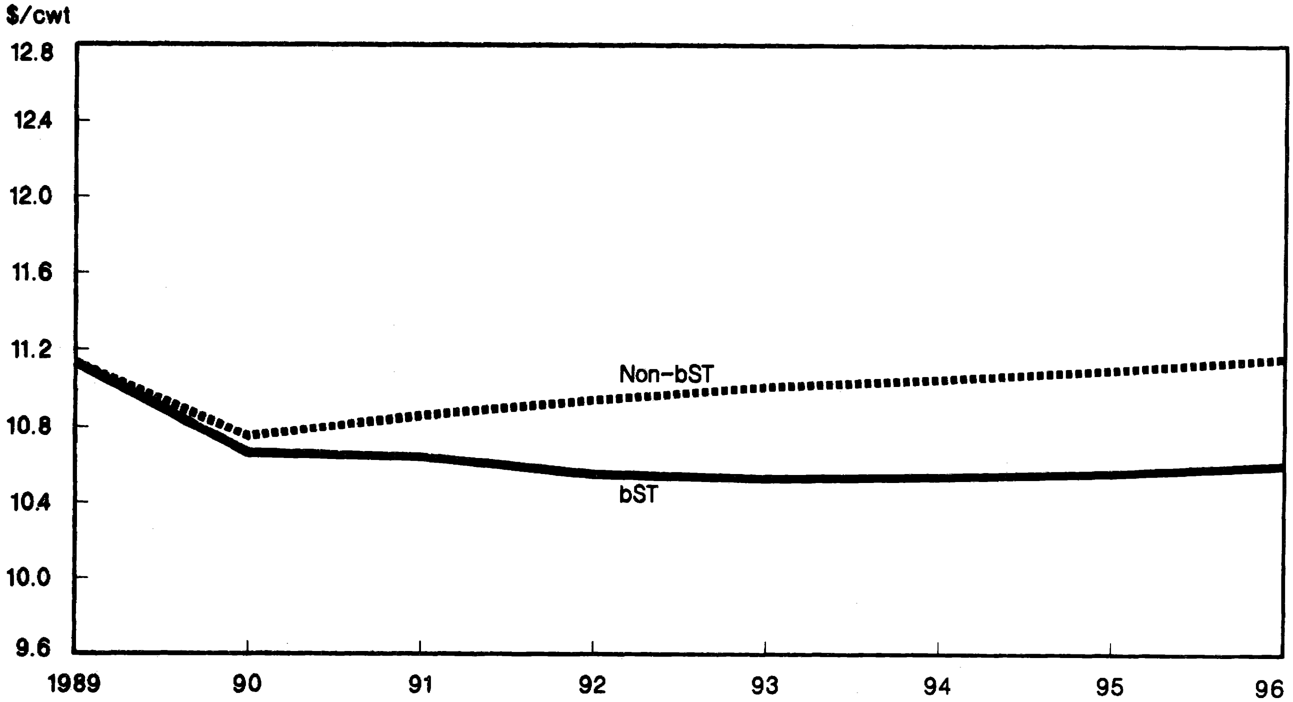
Cow numbers: Cow numbers decline further than under Scenario I because of the lower all-milk price both with and without bST (fig. 16). However, the increased productivity reflected in higher milk production per cow and lower costs of milk production with bST still are able to counteract the effect of lower all-milk prices. Therefore, dairy farm profitability and the resulting cow numbers follow the same general trend with and without bST. Cow numbers start at about 10.3 million in 1990 and decline with or without bST to 9.4 million by 1996.

Total milk production: Total milk production, with or without bST, is less under Scenario II than Scenario I because of lower prices, but the effect of bST is about the same (fig. 17). The non-bST trend for U.S. production increases slightly to 150.1 billion pounds in 1996. The bST trend increases to 158.4 billion pounds in 1996, a 5.5-percent difference between trends.

Commercial milk and dairy product use: Lower consumer milk prices raise commercial disappearance (fig. 18). But again, because of inelastic milk demand, the difference between the two trends is the same as in Scenario I, amounting to about 400 million pounds by 1996.

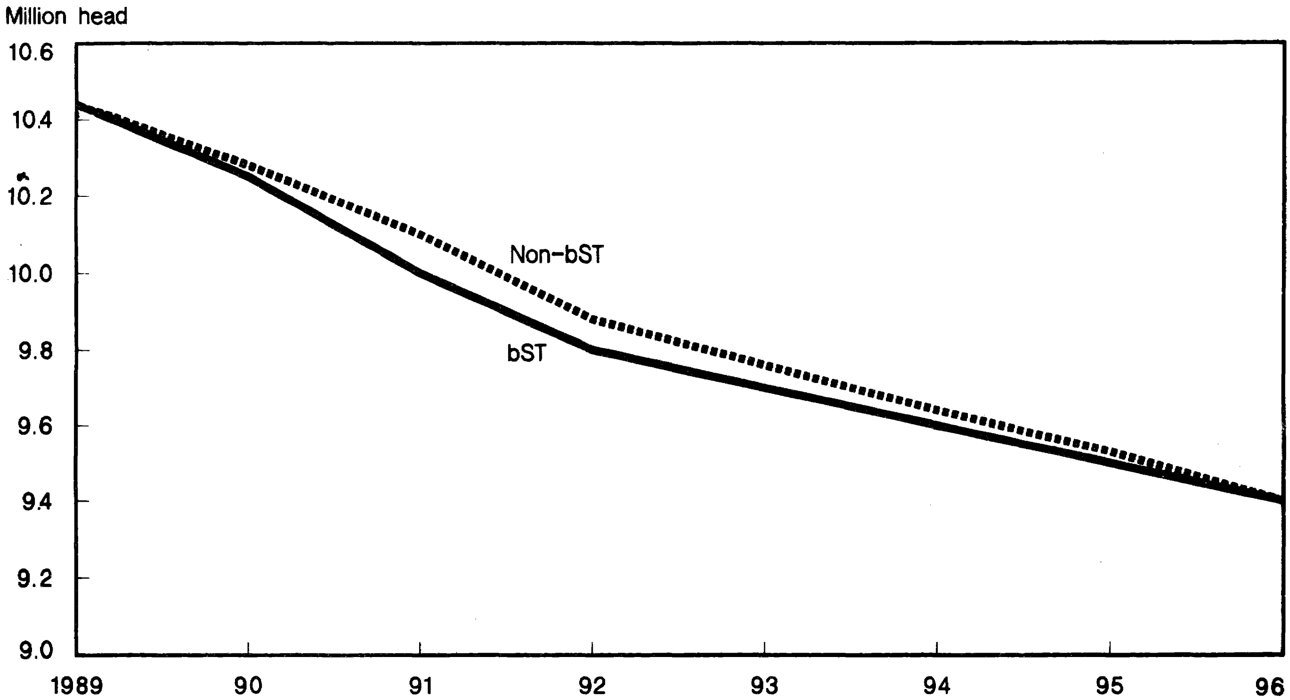
Government purchases: Government purchases are lower than in Scenario I because of the lower support price and fewer cow numbers in Scenario II (fig. 19). The bST trend increases slightly, while the non-bST trend steadily declines, amounting to a difference of 8 billion pounds by 1996.

Figure 15
Scenario II: U.S. all-milk price[1]



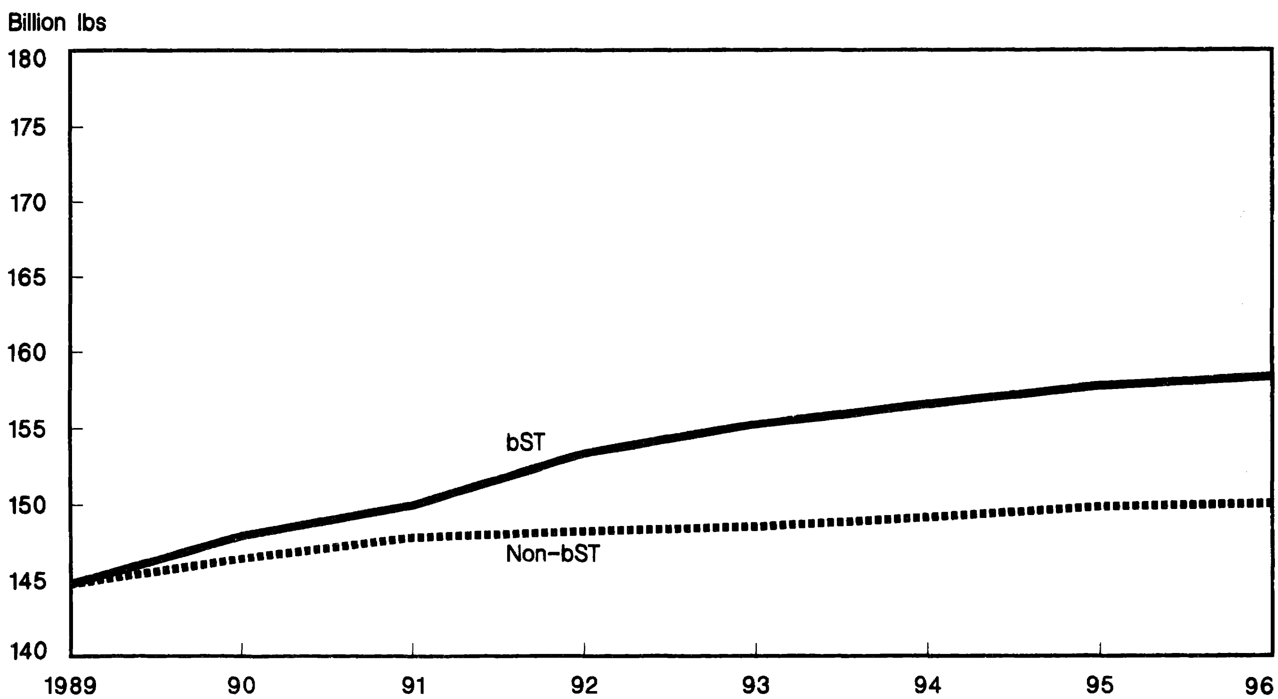
1/ Minimum $9.60 support price.

Figure 16
Scenario II: Number of U.S. dairy cows[1]



1/ Minimum $9.60 support price.

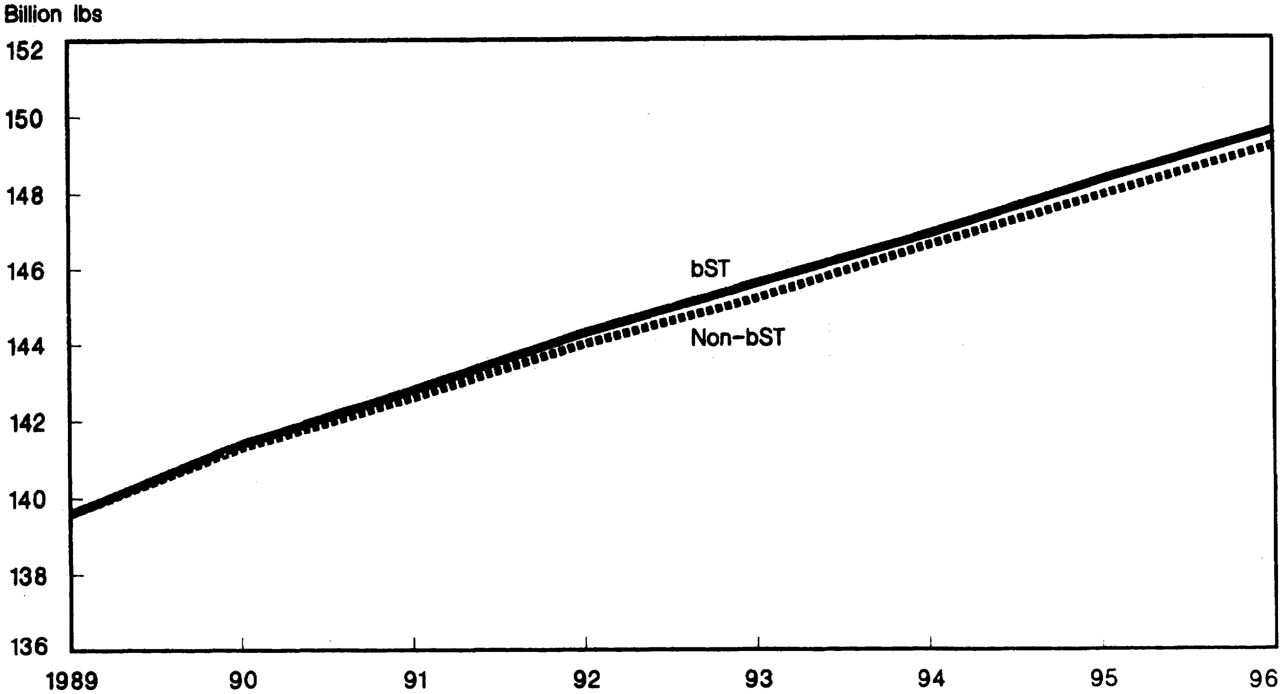
Figure 17
Scenario II: U.S. milk production[1]



1/ Minimum $9.60 support price.

Figure 18

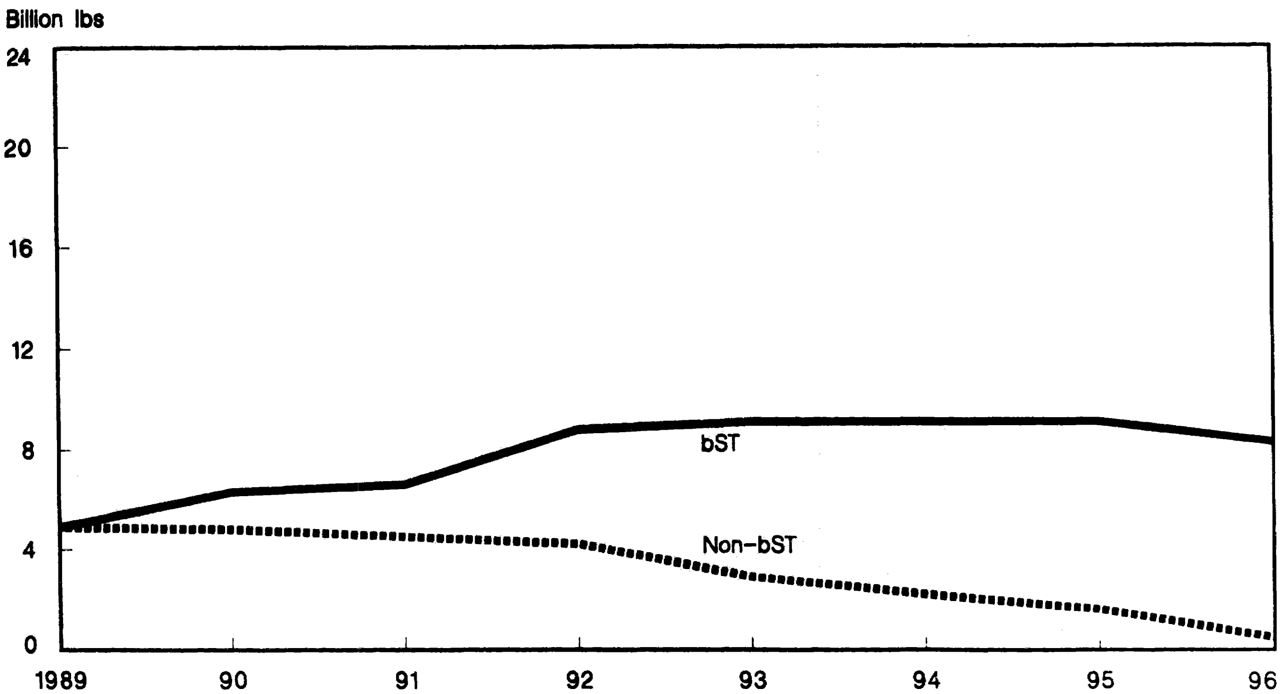
Scenario II: U.S. commercial disappearance[1]



1/ Minimum $9.60 support price.

Figure 19

Scenario II: U.S. Government purchases[1]



1/ Minimum $9.60 support price.

SCENARIO III

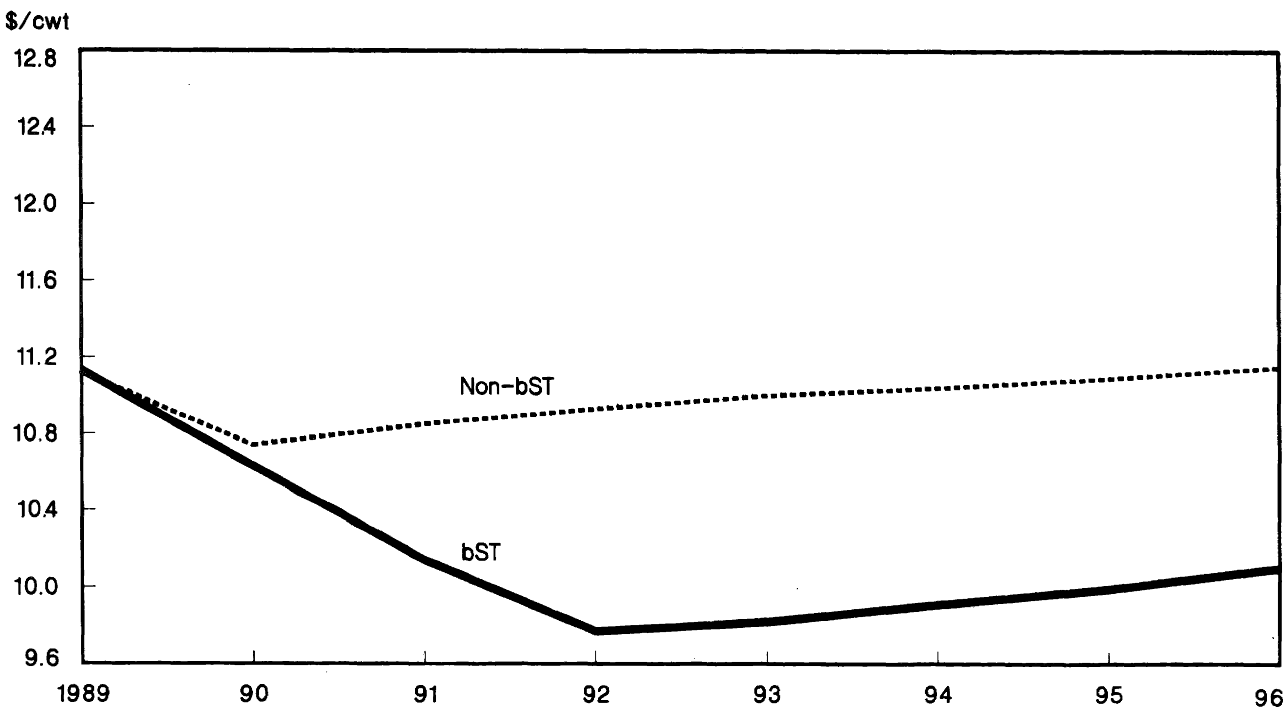
This scenario assumes a support price of $9.60 in 1990. However, this scenario allows two further 50-cent annual reductions in the support price if Government purchases are projected to exceed 5 billion pounds in any calendar year. The lowest support price allowed in this scenario is $8.60.

Under Scenario III, in which prices are allowed to fall to about equilibrium levels, exits from the industry rise considerably with bST, amounting to a loss of over 300,000 cows more than without bST (see Appendix III). In contrast, under the higher support levels of Scenarios I and II, bST raises Government purchases but has only a modest effect on cow numbers and milk prices. Milk prices in Scenario III decline 9 percent with bST use with concurrent consumer savings. Government purchases also fall for both bST and non-bST. By 1996, Government purchases are only 43 percent of 1989 levels even with bST.

All-milk price: The non-bST trend for the all-milk price is stable at around $11 per cwt (fig. 20). Under the bST trend, price supports are reduced in 1991 and 1992, dropping the all-milk price to about $10, $1 below the non-bST trend of about $11.

Cow numbers: Cow numbers are further reduced because of the lower all-milk price with bST (fig. 21). Increased productivity with bST does not completely counteract the effect of significantly lower milk prices. The non-bST trend for cow numbers drops to 9.4 million in 1996, compared with the bST trend of 9.1 million.

Figure 20
Scenario III: U.S. all-milk price[1]



1/ Minimum $8.60 support price.

Total milk production: Total milk production with or without bST is lower than under the other scenarios (fig. 22). The non-bST trend for total production increases to 150 billion pounds in 1996. Because of low milk prices, the effect of bST on production is quite moderate, increasing production to 153 billion pounds in 1996, about a 2-percent difference between the two trends.

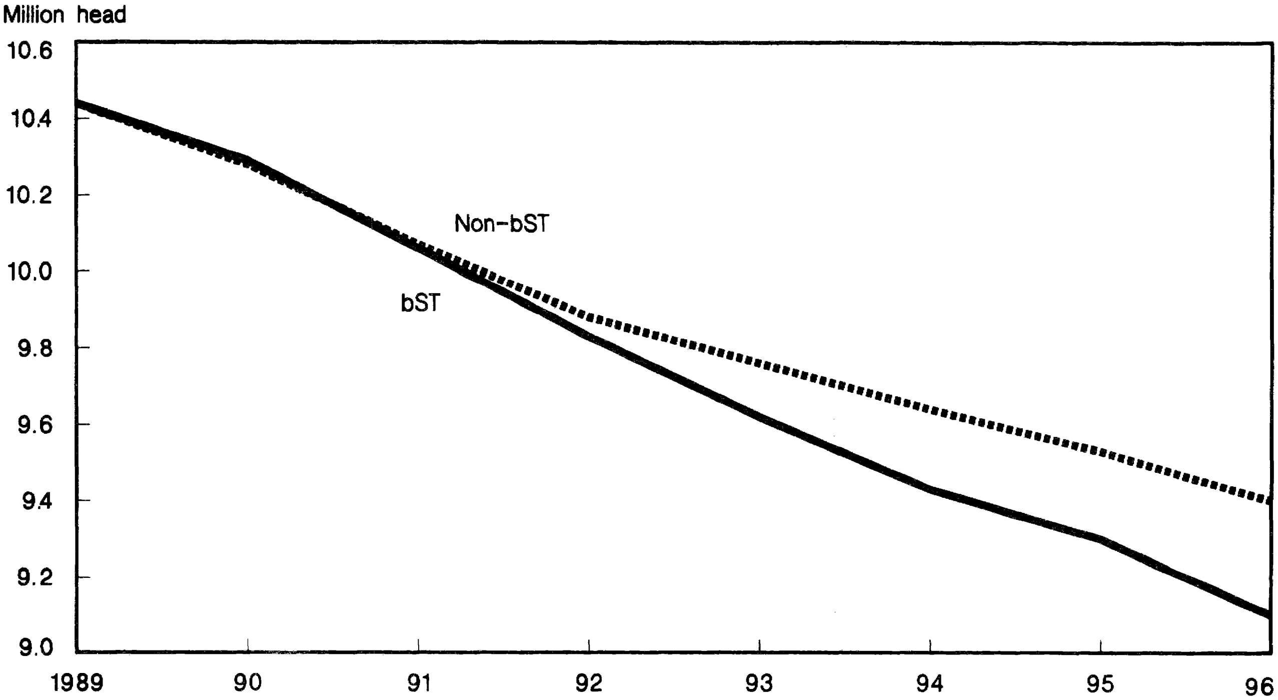
Commercial milk and dairy product use: Lower consumer milk prices with bST slightly increase commercial disappearance (fig. 23.) Although Scenario III shows the largest difference between bST and non-bST milk prices, the inelastic milk and dairy product demand minimizes the price effect. The difference between the two trends in commercial use amounts to 700 million pounds (less than 1 percent) over the 1991-96 period.

Government purchases: The lower support price and fewer cows reduce Government purchases with and without bST. However, the bST trend rises slightly through 1992, but then steadily declines. Government purchases with bST range from 1.5 to 4.5 billion pounds above the non-bST level, and the difference between the two trends by 1996 is about 2 billion pounds (fig. 24). Thus, a flexible support price even with bST can accommodate this new technology without resulting in large increases in Government purchases.

SCENARIO IV

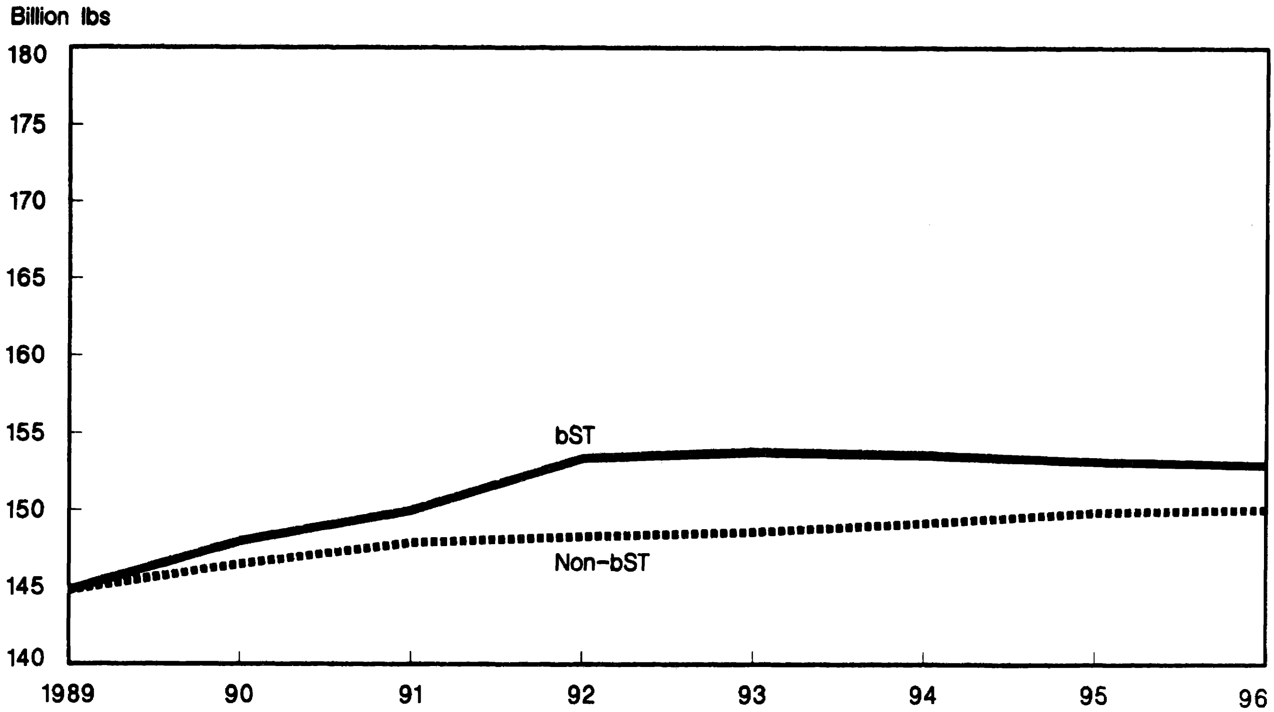
This scenario maintains the support price at $11.10 per cwt from 1990 through 1996, regardless of supply and demand conditions and amount of Government dairy product purchases.

Figure 21
Scenario III: Number of U.S. dairy cows[1]



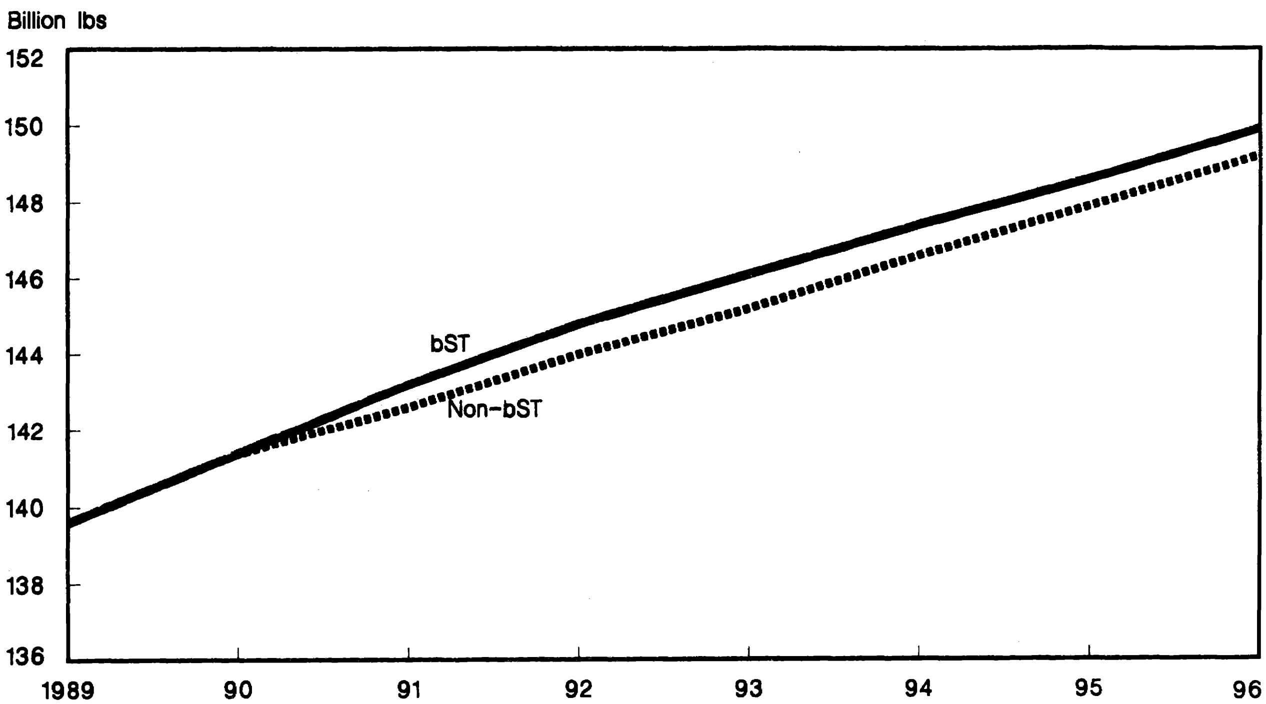
1/ Minimum $8.60 support price.

Figure 22
Scenario III: U.S. milk production[1]



1/ Minimum $8.60 support price.

Figure 23
Scenario III: U.S. commercial disappearance[1]



1/ Minimum $8.60 support price.

This scenario allows more financially marginal producers to stay in business by maintaining the support price at $11.10 regardless of the level of Government purchases (see Appendix III). Scenario IV demonstrates the effects of an inflexible agricultural price support program under conditions of substantial technological change. Large, increasing Government purchases reflect milk supplies in excess of commercial use due to relatively high milk prices.

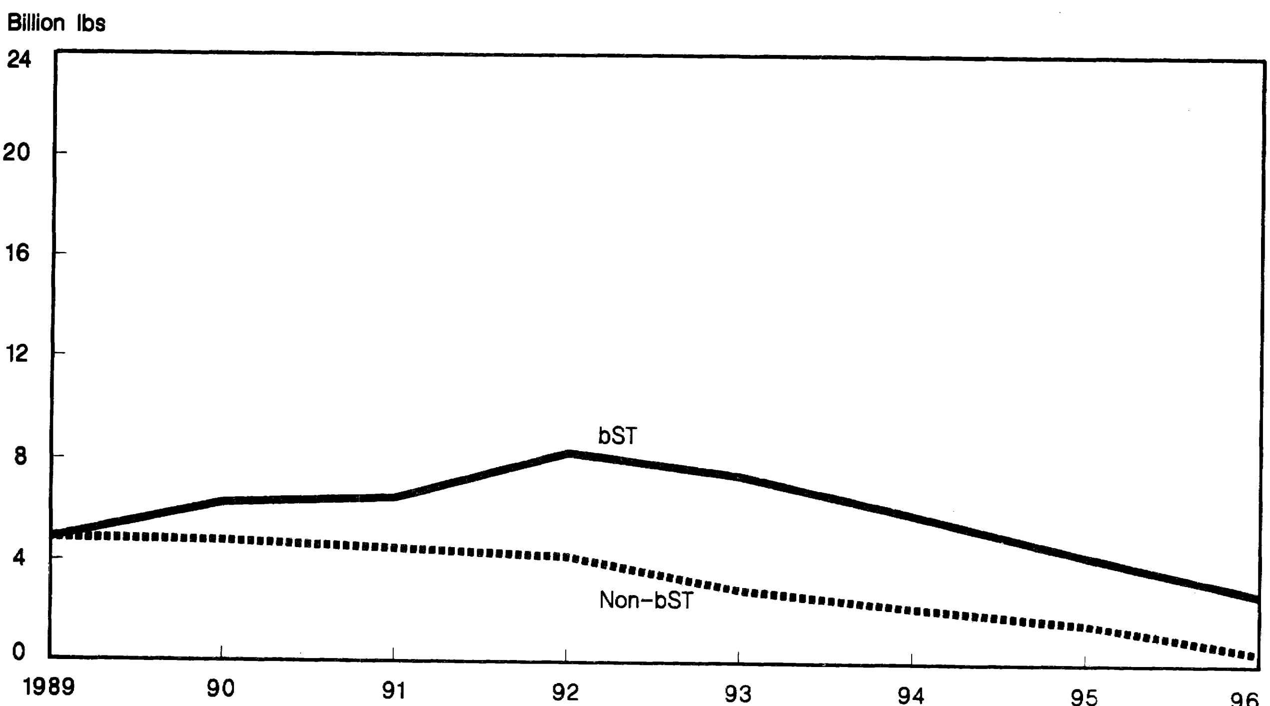
All–milk price: The milk price varies little with and without bST, remaining between $12.35 and $12.53 for both situations (fig. 25).

Cow numbers: Increased productivity with bST and constant milk prices maintain farm income and, thus, prevent a significant drop in cow numbers. The trend of declining cow numbers is even flatter with bST than without. The long–term downward trend is slight, reaching 10.2 million without bST and 10.4 million with bST by 1996 (fig. 26).

Total milk production: The combination of higher cow productivity with higher cow numbers significantly raises U.S. milk production with bST (fig. 27). The non–bST trend rises to around 162 billion pounds in 1996. The bST trend rises to 178 billion pounds, a 9.5–percent difference between the trends, the largest in any of the scenarios.

Commercial milk and dairy product use: The higher milk price with and without bST depresses commercial use somewhat compared with the other scenarios. However, the difference between the bST and non–bST trends is insignificant because the all–milk prices are essentially the same (fig. 28).

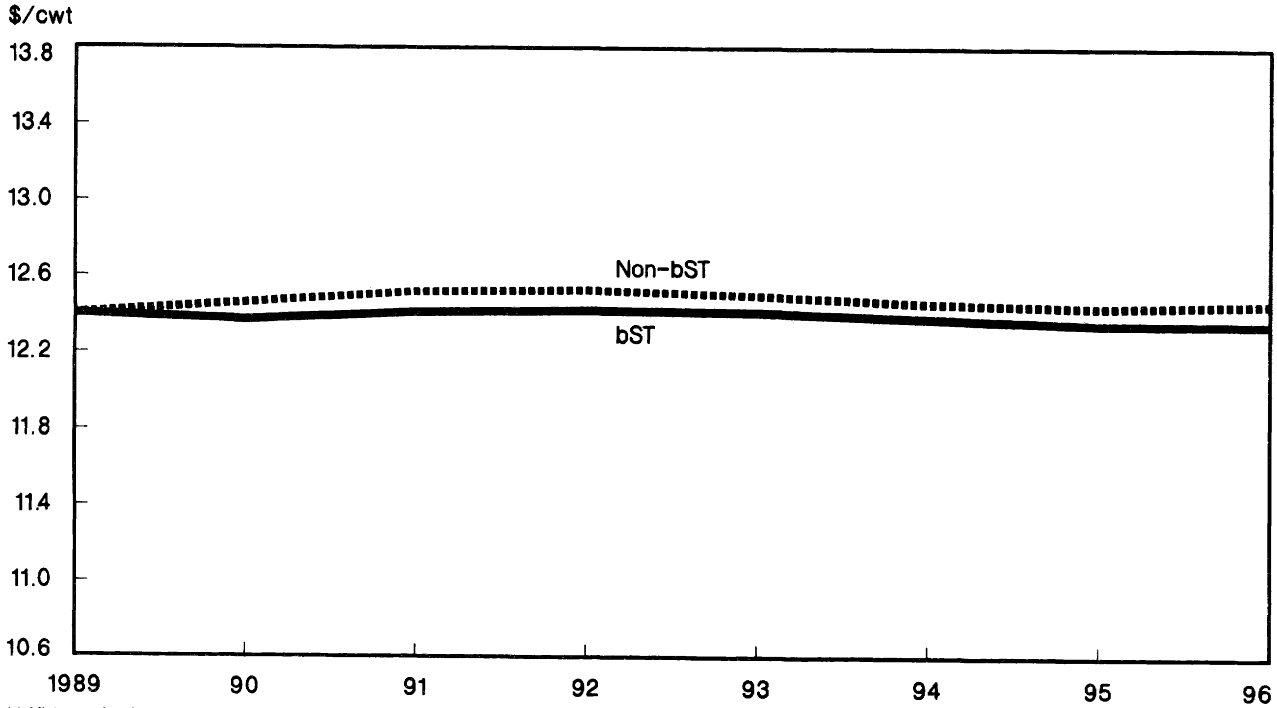
Figure 24
Scenario III: U.S. Government purchases[1]



1/ Minimum $8.60 support price.

Figure 25

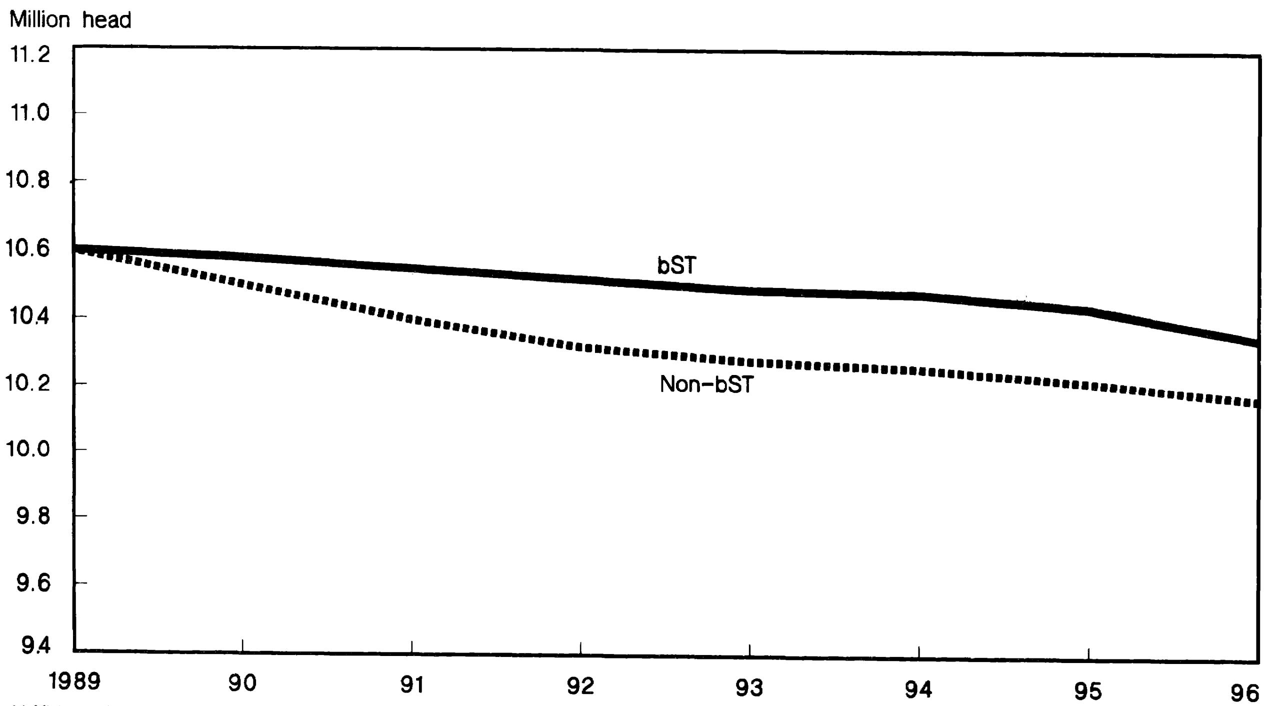
Scenario IV: U.S. all-milk price[1]



1/ Minimum $11.10 support price.

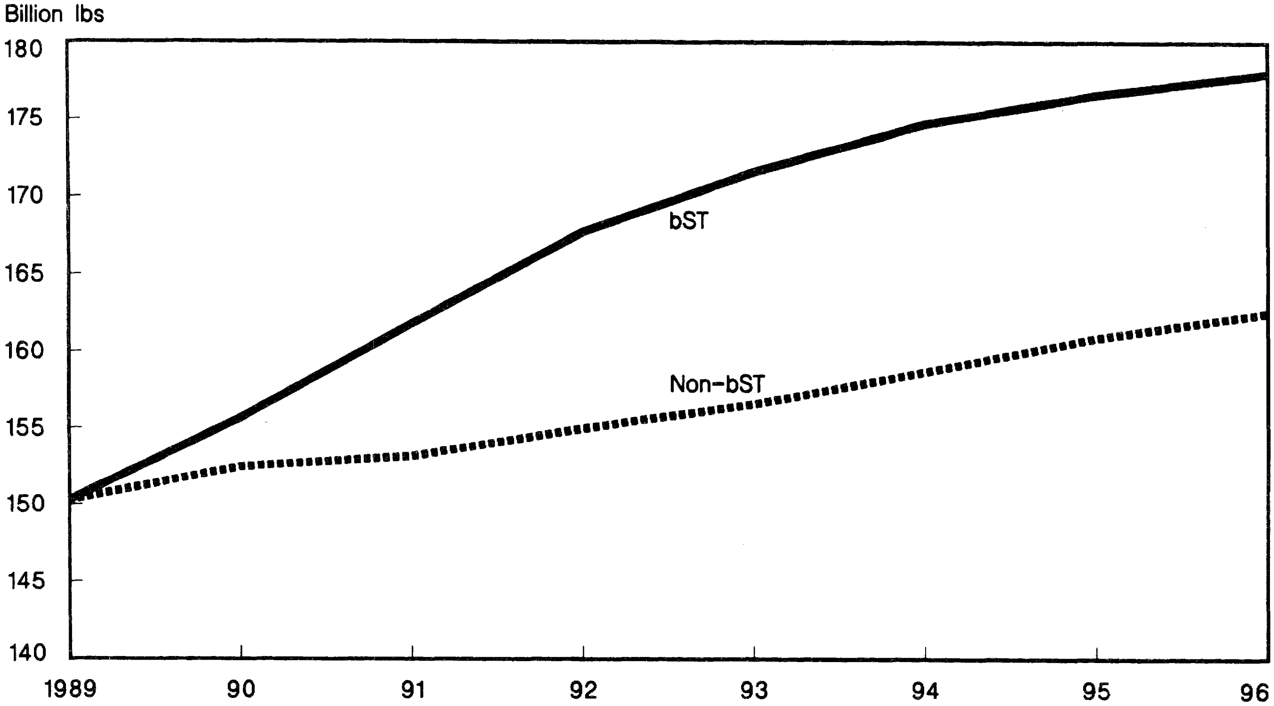
Figure 26

Scenario IV: Number of U.S. dairy cows[1]



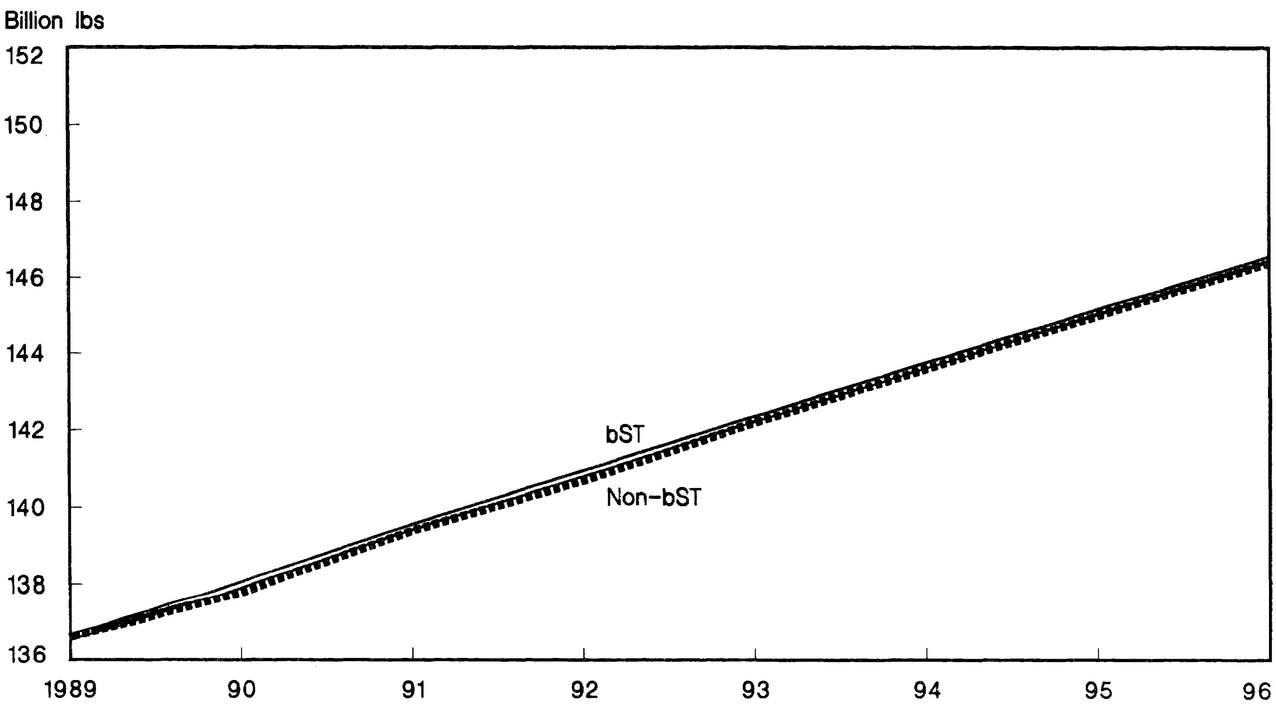
1/ Minimum $11.10 support price.

Figure 27
Scenario IV: U.S. milk production[1]



1/ Minimum $11.10 support price.

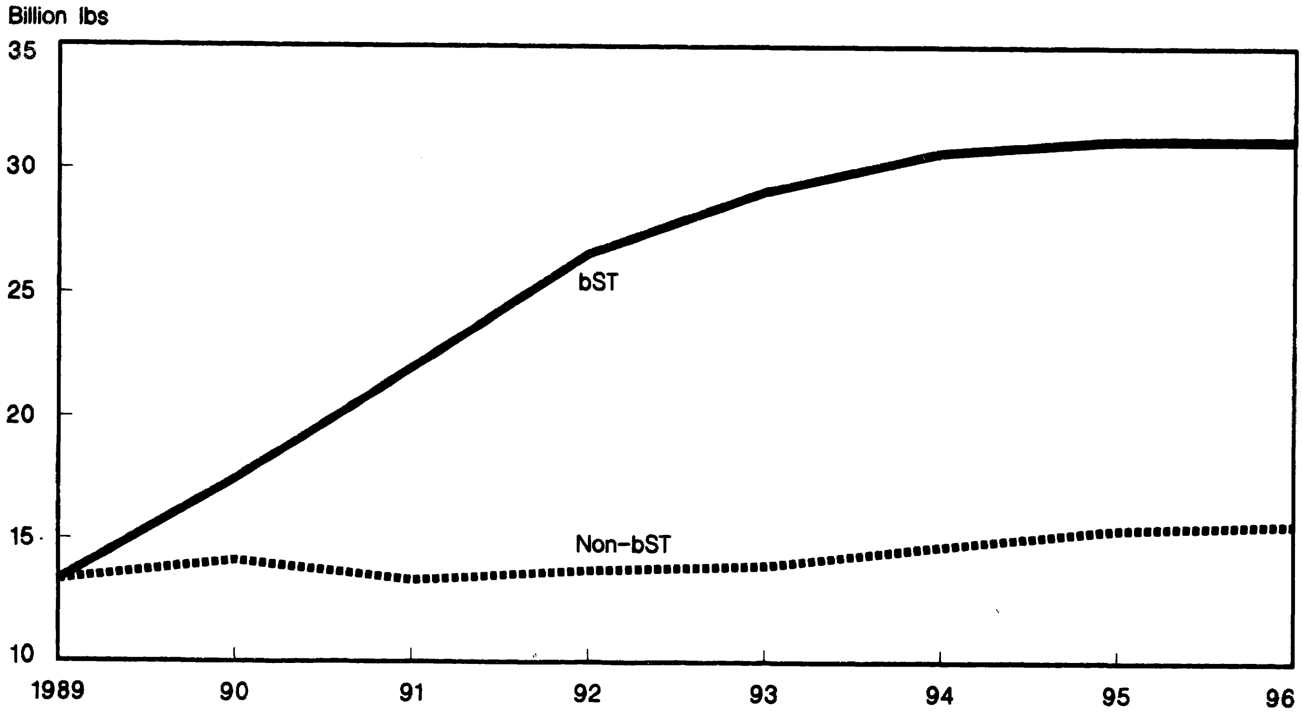
Figure 28
Scenario IV: U.S. commercial disappearance[1]



1/ Minimum $11.10 support price.

Government purchases: Government purchases of surplus products to maintain the $11.10 support price are considerable, and bST accentuates the situation (fig. 29). The bST trend rises to 31 billion pounds in 1996. The non-bST trend rises to around 15 billion pounds, a difference of 16 billion pounds. bST use, compared with the non-bST situation, in Scenario IV has the largest effect on Government purchases than in the other scenarios.

Figure 29
Scenario IV: U.S. Government purchases[1]



1/ Minimum $11.10 support price.

Chapter VIII

Structural Effects of bST on the Dairy Industry

Adopting bST under Scenarios I, II, and IV increases the viability of all representative dairy farms despite lower milk prices, because of reduced production costs. Net worth increases because milk production costs drop more than does the revenue associated with lower milk prices. A significant drop in farm numbers with bST is consistent with trends dating back to 1955: fewer dairy farms, larger herds, and growing productivity. bST has little effect on the regional location of milk production or on the size distribution of dairy farms.

FINANCIAL CONDITIONS

Viability of all representative dairy farms generally increases with adoption of bST, despite the milk price being depressed by higher milk production. Net worth increases because costs of producing milk decline more than does revenue associated with lower milk prices. For farms not adopting bST, the lower milk prices without corresponding reductions in milk production costs reduce net worth. For most larger farms, bST increases profitability. For smaller farms, bST is generally profitable at the $10.10 and $9.60 support prices. At lower support prices, bST makes little difference in the viability of inefficient farms.

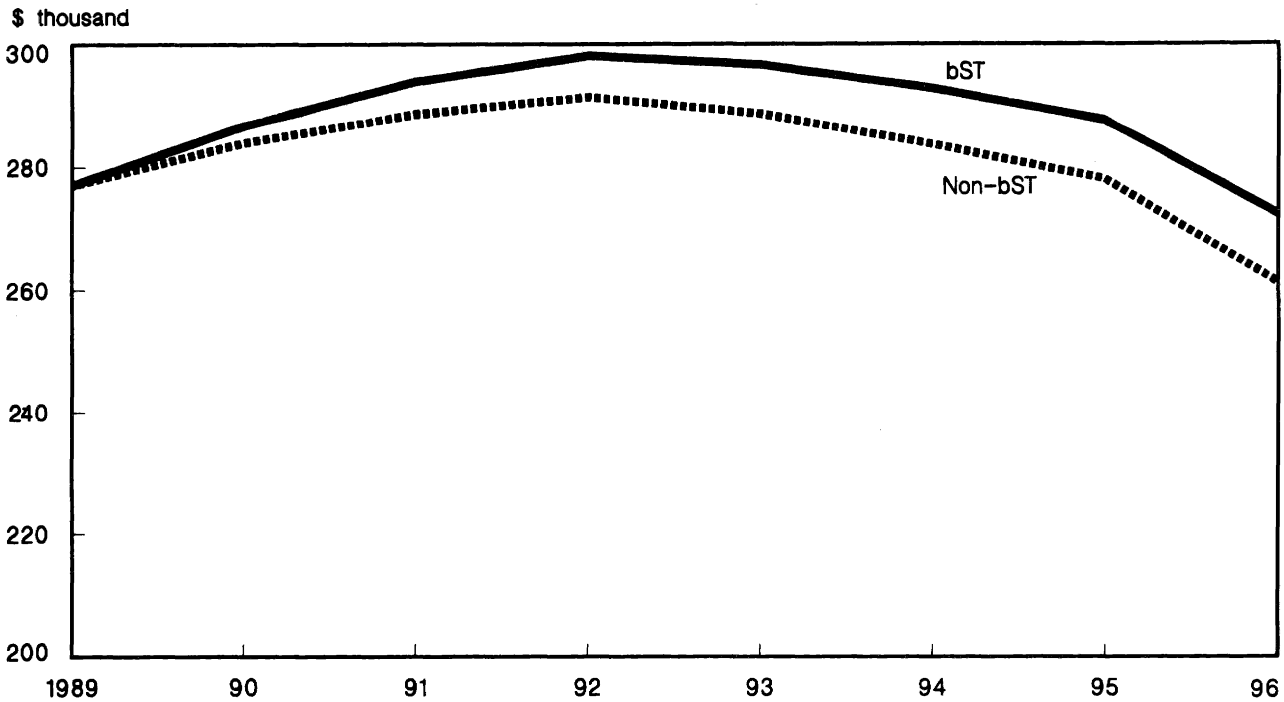
Comparisons in this section are limited to two farm sizes in the Lake States because of the large number (150) of representative farms in different regions and possible initial financial conditions. However, the results presented here are consistent with other U.S. dairy regions. A 50-cow farm and a 300-cow farm represent smaller farms and larger farms. We assumed both farms to have the same initial debt/asset ratio. These two representative farms were chosen to illustrate overall structural adjustments and trends in the industry.

Scenario I (support price of $10.10): The net worth of smaller farms using bST is higher than that for farms that do not use bST (fig. 30). Net worth with and without bST rises until 1992, when they level off or fall from a combination of the lower milk price and refinancing requirements of replacement machinery. Use of bST moderately enhances the already increasing net worth of larger farms (fig. 31).

Scenario II (support price of $9.60): The financial condition of the two representative farms is similar to that in Scenario I, except that continuing declines in the all-milk price either dampen growth in net worth on some farms or exacerbate declining net worth on others. Net worth of smaller farms substantially drops after 1992 with and without bST because the price level is simply too low to maintain income (fig. 32). Net worth of larger farms, however, still rises with bST use, further enhancing net worth (fig. 33).

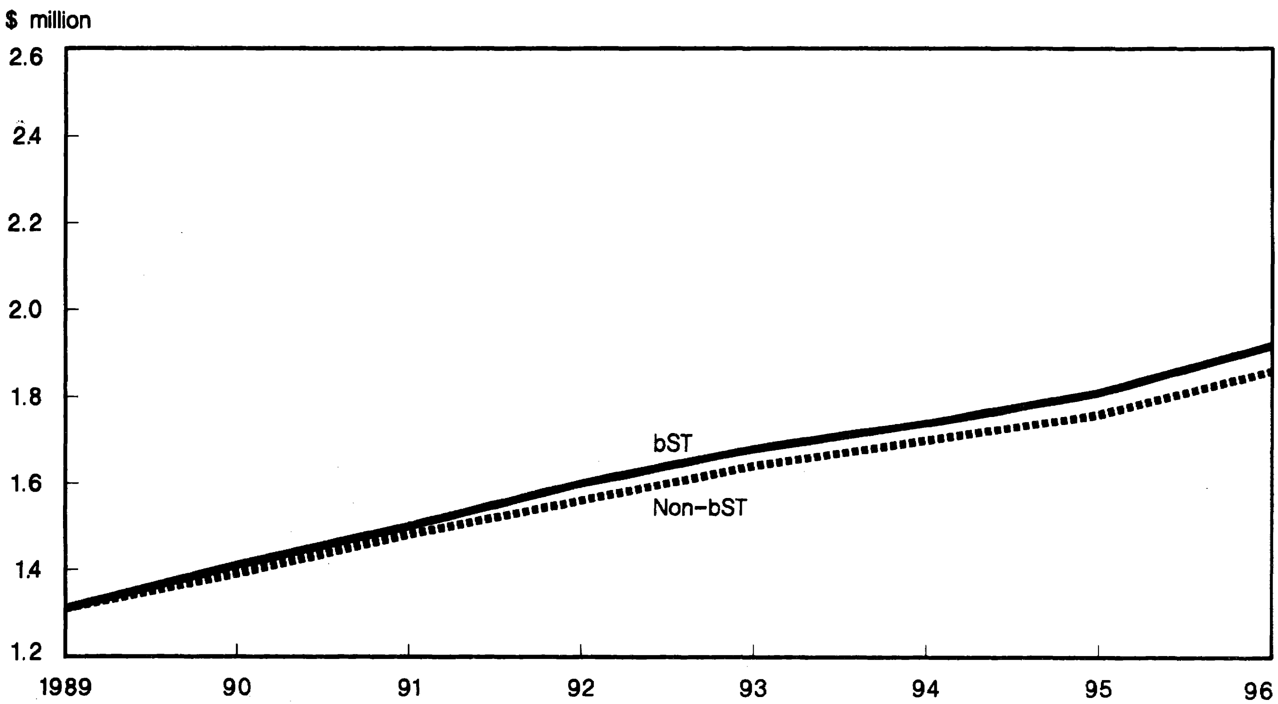
Scenario III (support price of $8.60): The net worth of smaller farms substantially declines in later years with and without bST, but bST use further accentuates the decline (fig. 34). The all-milk price declines more with bST use than without. These price interactions (the milk price reduction exceeds operating cost reductions) reduce net worth. The net worth of larger farms still grows both with and without bST, but lower milk prices due to industry use of bST entirely negate the potential added revenue associated with increased milk production with bST (fig. 35).

Figure 30
Scenario I: Net worth of a 50-head dairy farm in the Lake States[1]



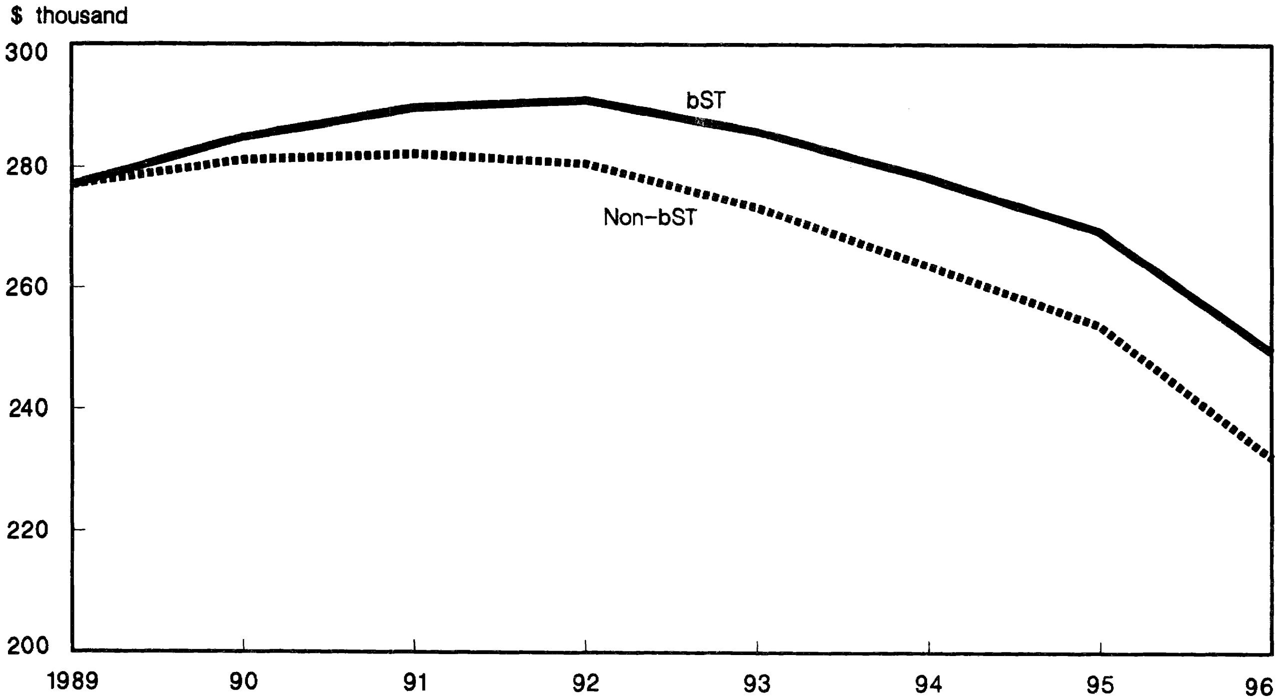
1/ Minimum $10.10 support price.

Figure 31
Scenario I: Net worth of a 300-head dairy farm in the Lake States[1]



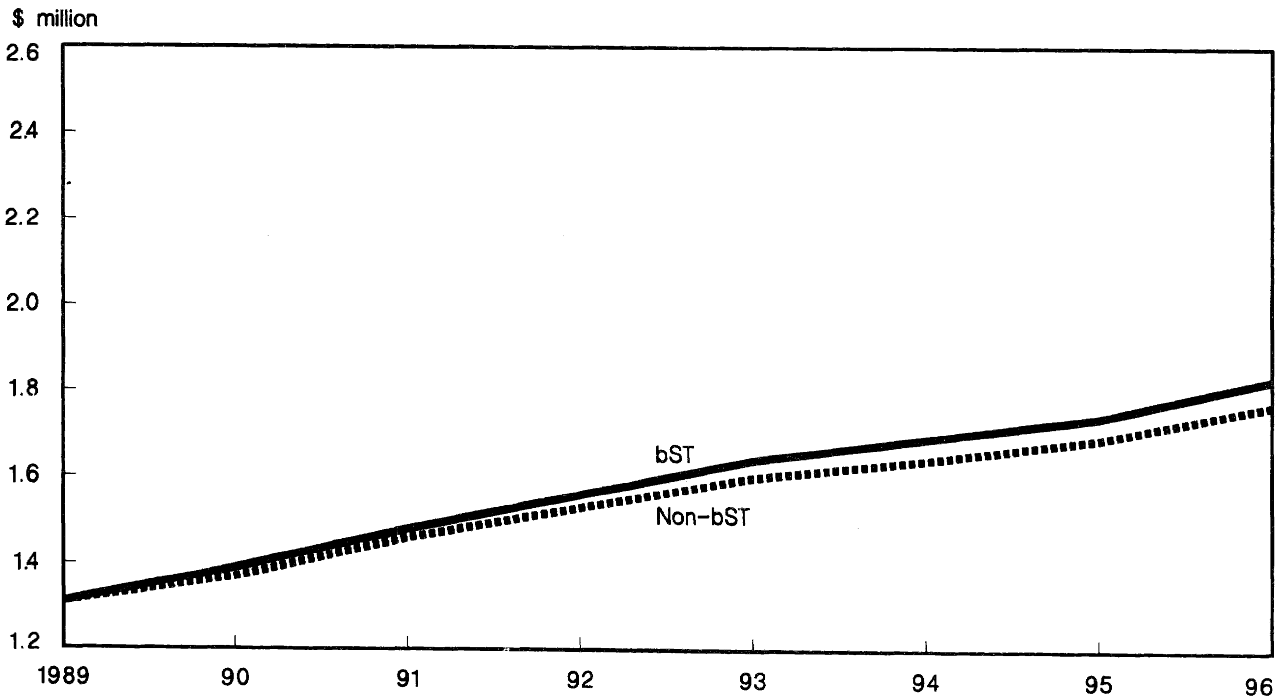
1/ Minimum $10.10 support price.

Figure 32
Scenario II: Net worth of a 50-head dairy farm in the Lake States[1]



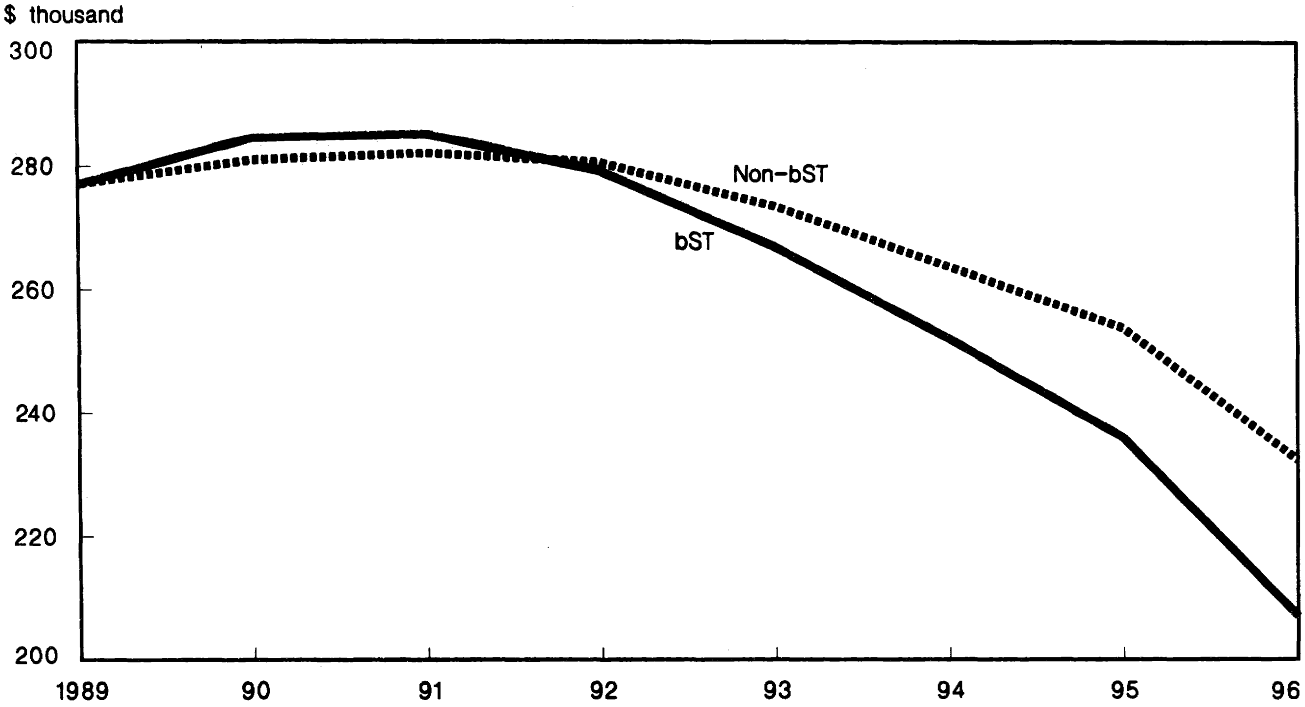
1/ Minimum $9.60 support price.

Figure 33
Scenario II: Net worth of a 300-head dairy farm in the Lake States[1]



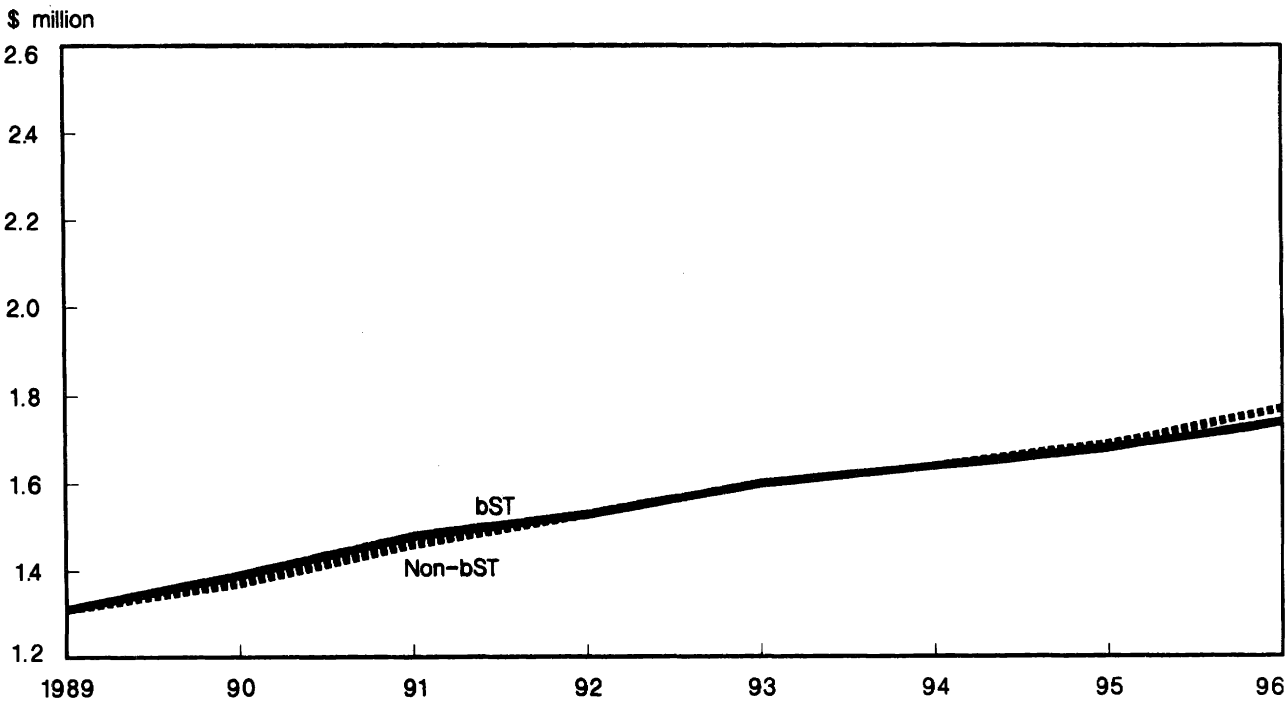
1/ Minimum $9.60 support price.

Figure 34
Scenario III: Net worth of a 50-head dairy farm in the Lake States[1]



1/ Minimum $8.60 support price.

Figure 35
Scenario III: Net worth of a 300-head dairy farm in the Lake States[1]



1/ Minimum $8.60 support price.

Scenario IV (support price of $11.10): Milk prices remain constant over the projected timeframe. Net worth of most farms is constant or increasing. For smaller farms, bST forestalls a leveling off of net worth in later years and heavily encourages adoption of bST (fig. 36). For larger farms, bST accelerates growth in net worth and again would encourage adoption of bST (fig. 37).

REGIONAL CHANGES IN COW AND FARM NUMBERS

The general increase in dairy productivity has significantly cut farm numbers and size of the national cow herd. Introduction of bST would continue the decline in both cow and farm numbers, consistent with historical trends. This section compares cow and farm numbers in 1986 with those in 1996 with and without bST. Structural changes in this chapter are expressed as annual rates of change in cow and farm numbers relative to a 1986 base estimate of farm and cow numbers by region.

The Lake States and Northeast regions generally have the highest rate of exit of all scenarios because of their lower milk prices (relative to other regions), high capital costs, and average milk production levels per cow. The Pacific region has moderate rates of exit because of high milk production levels per cow. The Corn Belt, Southern Plains, and Appalachian regions also have more moderate rates of exit because of outside sources of income and more income from alternative agricultural enterprises. The lowest rates of exit are in the Southeast which has higher milk prices than other regions because of Federal milk order price differentials and high fluid milk use. General structural changes for each scenario are outlined below. More detailed estimates of farm and cow number changes are presented in Appendix IV.

Scenario I
($10.10 Support Price)

Differences in structural changes between bST use and non-use are small for all regions (figs. 38 and 39). The Northeast has the highest annual decrease (about 2 percent) in cow and farm numbers with or without bST. Farms with 50–99 cows account for much of this decline. The number of farms with 100 or more cows rises because of significant economies of scale, and farms with 250 or more cows increase 3.9 percent annually. Cow and farm numbers in the Lake States follow a similar pattern to farms in the Northeast with under 100 cows, declining about 2.6 percent annually with or without bST.

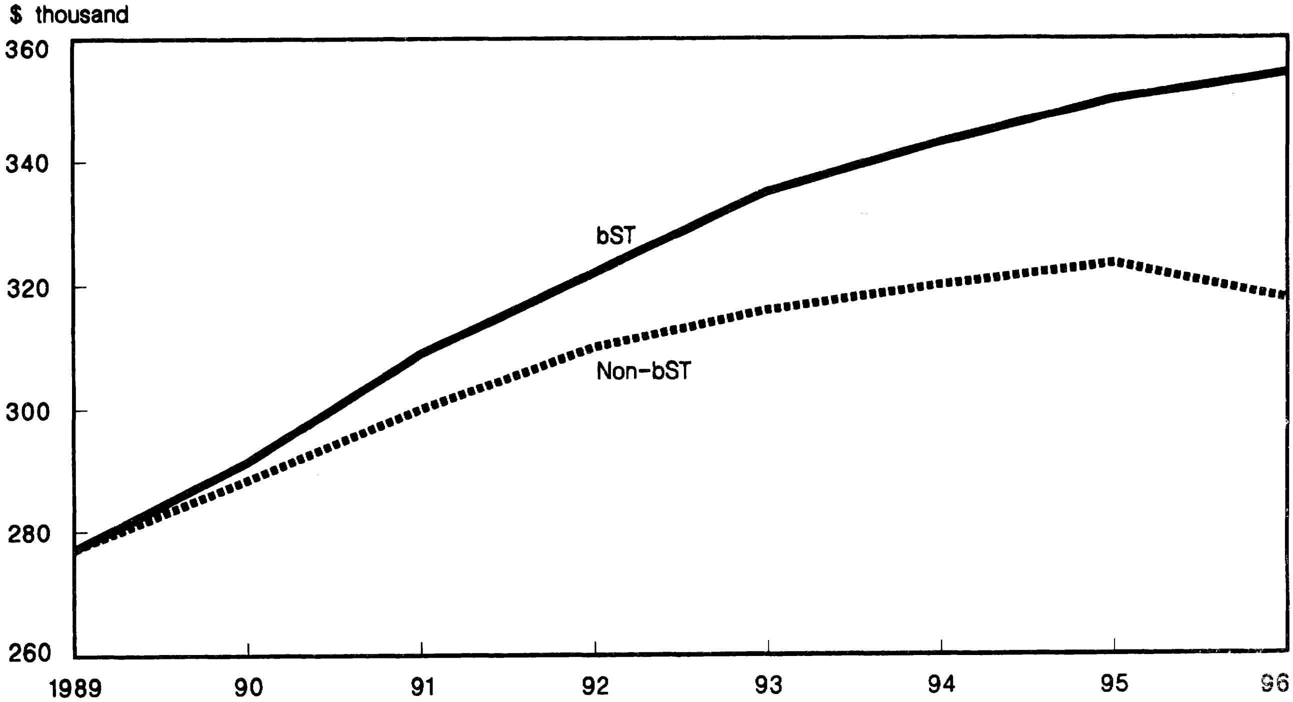
Farms in the Corn Belt and Appalachia follow the same pattern: small farm numbers drop and large farm numbers rise with or without bST. Cow and farm numbers in the Pacific and Southern Plains regions decline in all size ranges, although smaller farms fall at a faster rate than the larger farms. Cow and farm numbers change little in the Southeast because of high profitability.

Scenario II
($9.60 Support Price)

Structural changes are similar to Scenario I, except that the decline in cow and farm numbers is greater because of the lower support price. Again, differences in structural changes due to bST use are very small (figs. 40 and 41). Again, the Northeast has the highest annual decline (2 percent) in cow numbers, followed by the Lake States, Corn Belt, Pacific region, Southern Plains, Appalachia, and the Southeast. Farm numbers decline the most in the Lake States followed by the Northeast. Smaller farms in all regions have a greater rate of decline than larger farms.

Figure 36

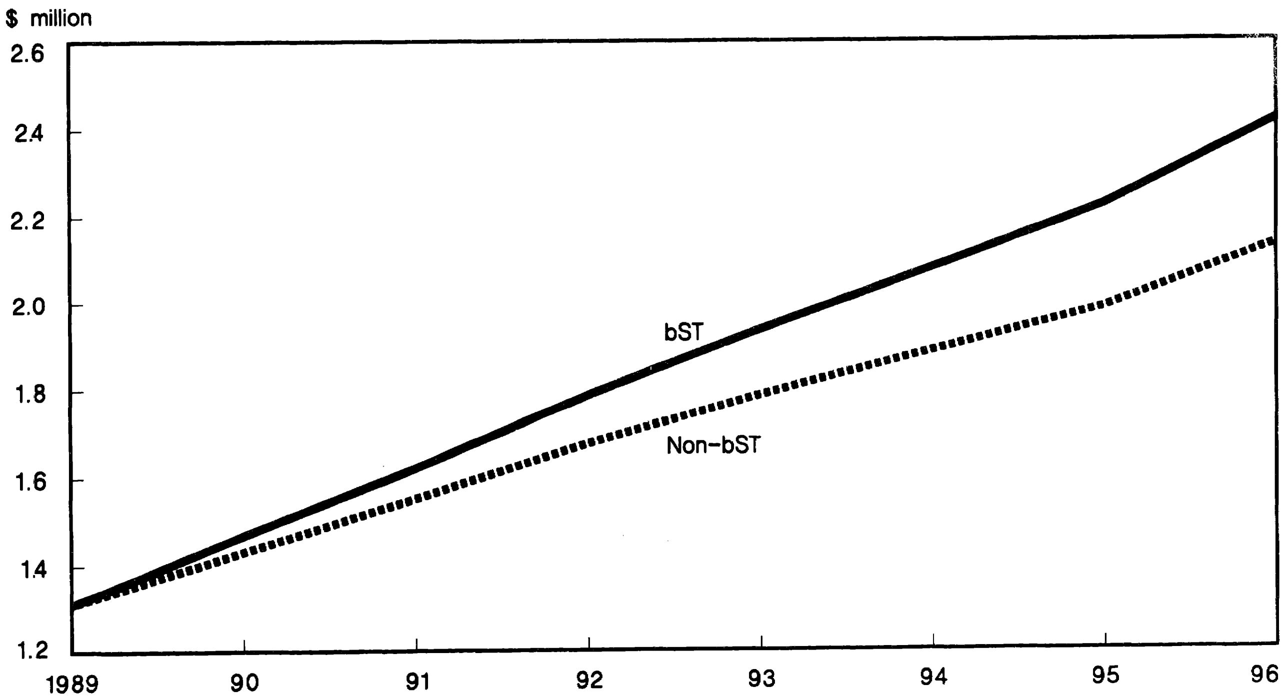
Scenario IV: Net worth of a 50-head dairy farm in the Lake States[1]



1/ Minimum $11.10 support price.

Figure 37

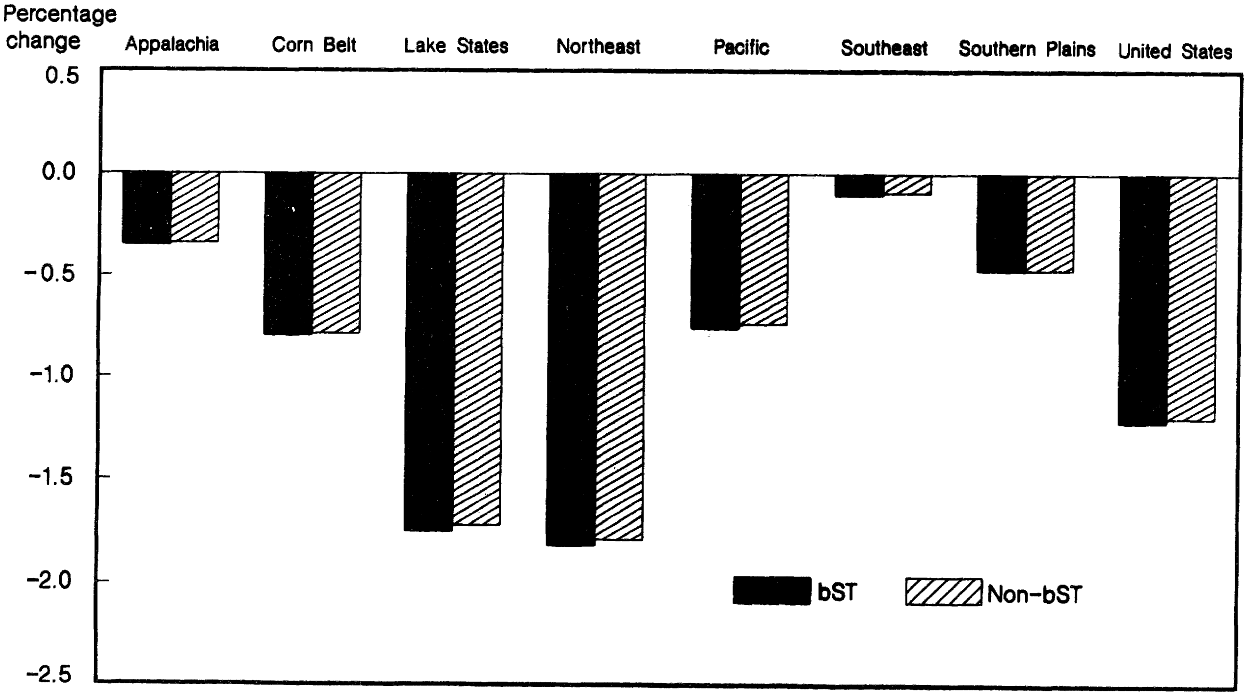
Scenario IV: Net worth of a 300-head dairy farm in the Lake States[1]



1/ Minimum $11.10 support price.

Figure 38

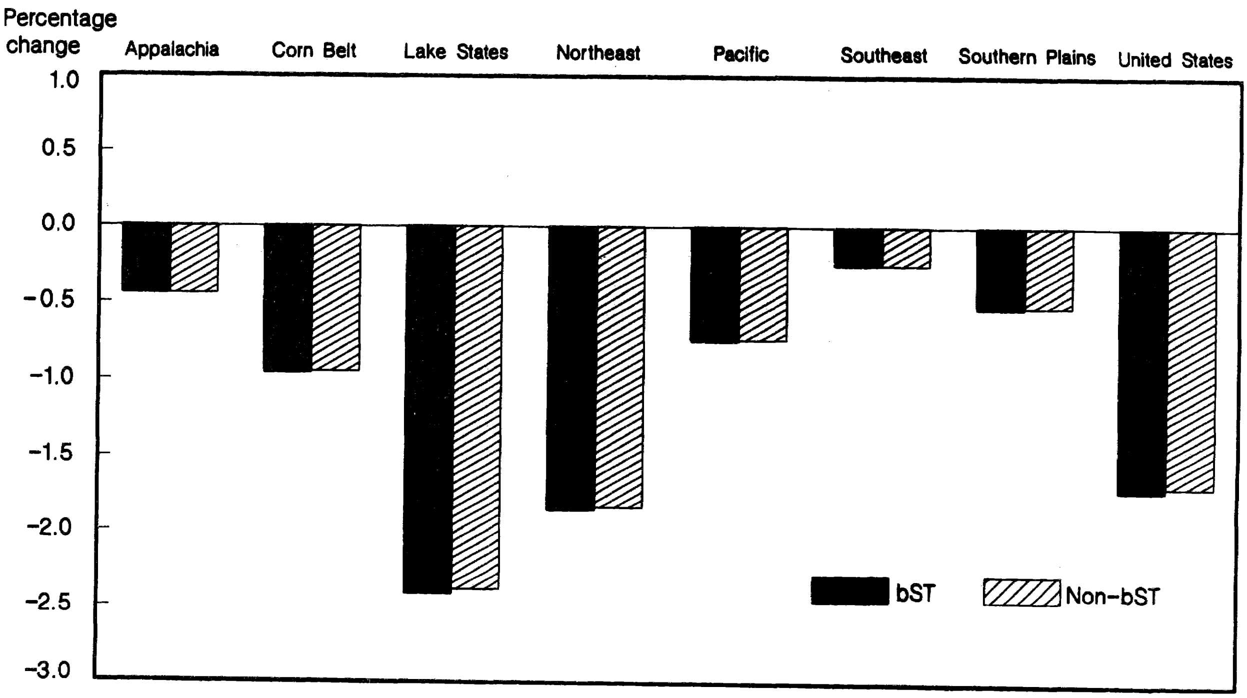
Scenario I: Annual average change in dairy cow numbers by region, 1986-96[1]



1/ Minimum $10.10 support price.

Figure 39

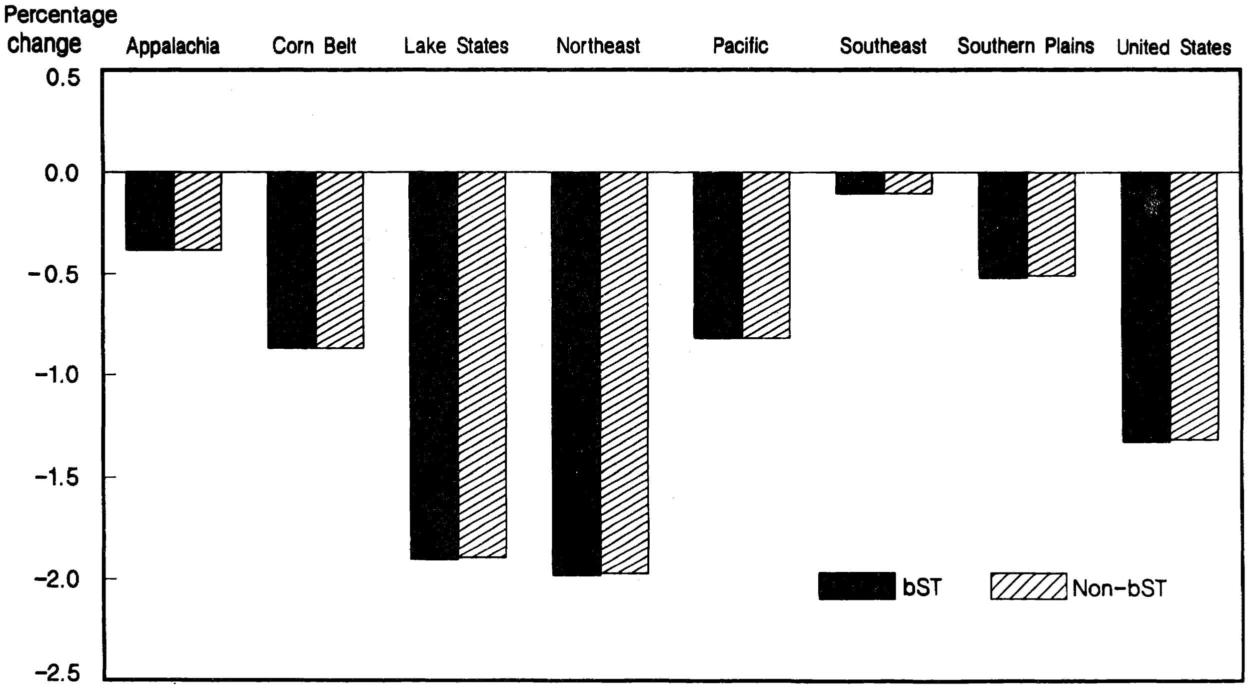
Scenario I: Annual average change in dairy farm numbers by region, 1986-96[1]



1/ Minimum $10.10 support price.

Figure 40

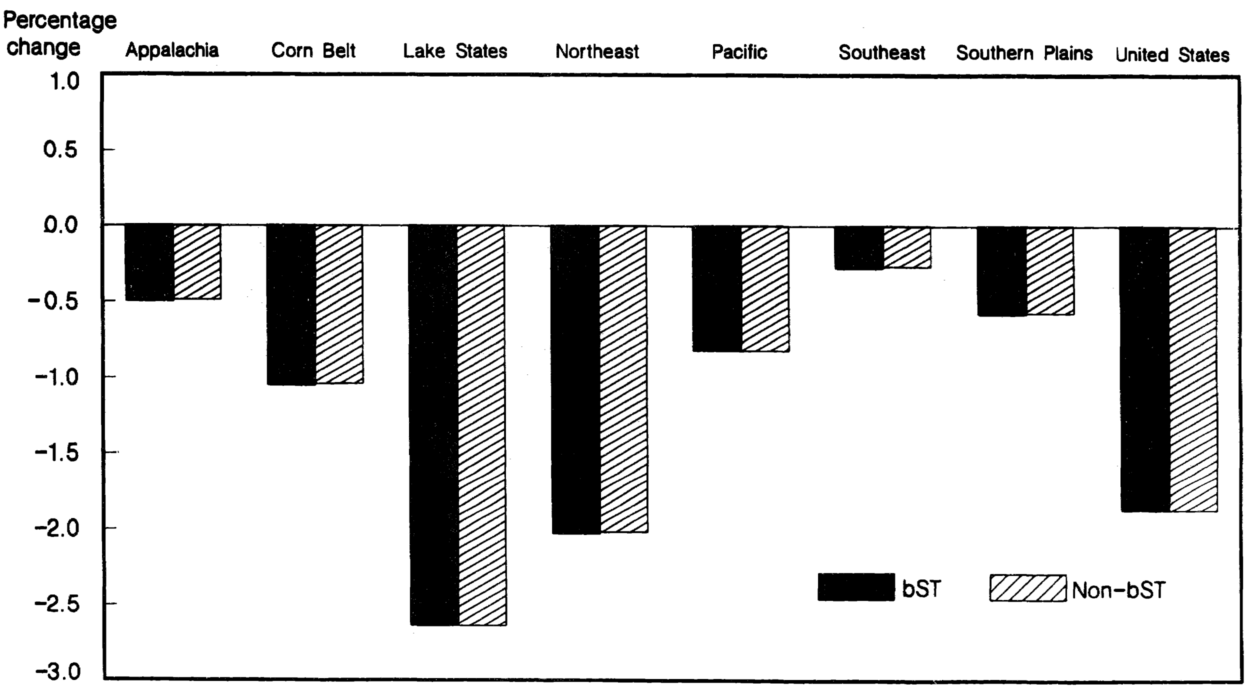
Scenario II: Annual average change in dairy cow numbers by region, 1986-96[1]



1/ Minimum $9.60 support price.

Figure 41

Scenario II: Annual average change in dairy farm numbers by region, 1986-96[1]



1/ Minimum $9.60 support price.

Scenario III
($8.60 Minimum Support Price)

Scenario III is the policy option that more closely approximates unsupported market conditions in 1990-96. With bST, the support price declines to $9.10 in 1991 and to $8.60 in 1992, lowering the average all-milk price received by farmers to about $10. Without bST, the support price remains at the $9.60 level over the full 1990-96 period because Government purchases do not exceed 5 billion pounds in any calendar year. Because the support price remains at $9.60 without bST, the all-milk price averages around $11 per cwt, about $1 per cwt above the situation with bST. When bST is used in the industry, the drop in milk prices (under Scenario III) is greater than the cost reduction from bST use, at least for some milk producers. Therefore, financial pressure on dairies generally increases (figs. 42 and 43). The differences with and without bST in the Lake States and Northeast are small, with annual farm exit rates of 2.0 and 2.6 percent, respectively. However, the differences with and without bST in Appalachia and the Corn Belt are practically nonexistent. Exit rates in other regions are significantly higher with bST. The Lake States and Northeast have higher fixed costs and lower outside income. Exit rates in the Pacific region double from 0.8 percent without bST to 1.9 percent with bST. The Southeast also experiences a significant decline of 0.7 percent with bST. Farms in the Pacific and Southeastern regions have lower overhead but higher operating costs; thus, farm viability is more sensitive to lower prices. The decline in most regions is in the small- and moderate-sized farms.

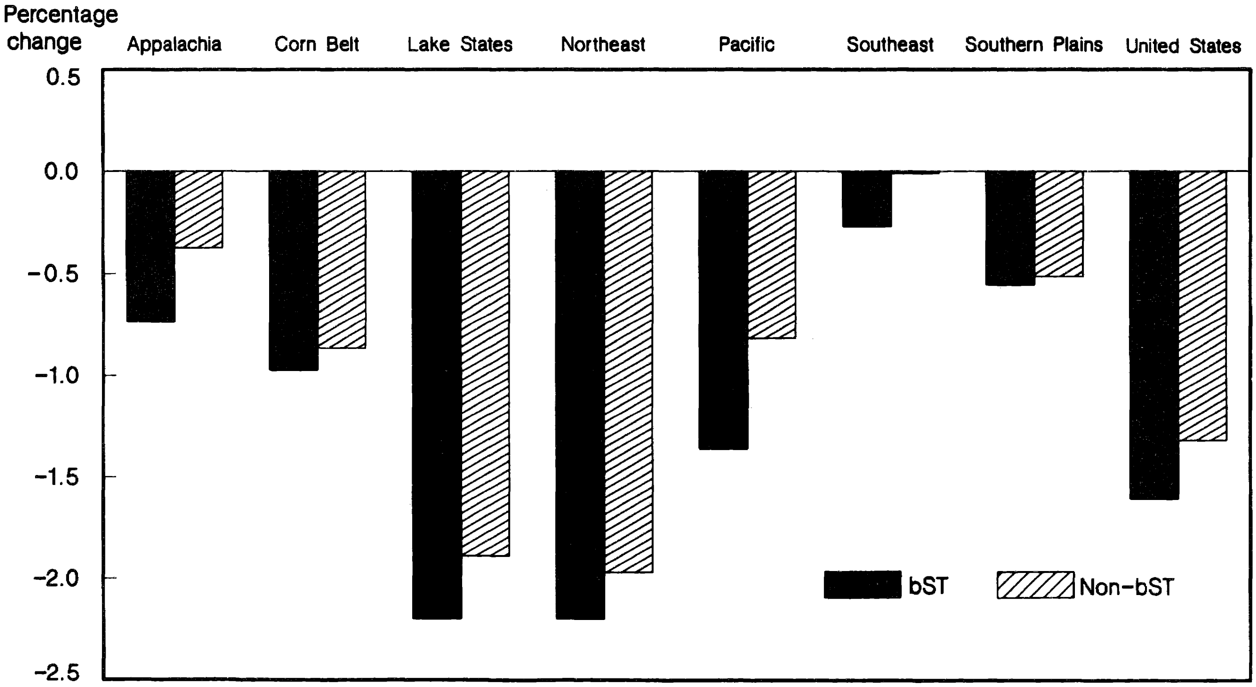
Scenario IV
($11.10 Support Price)

Scenario IV retains the $11.10 support price of 1987 which assists financially stressed producers. In contrast to Scenario III's low prices, more farms survive in this scenario and more capital (resources) is attracted into the industry. A general rise in production due to bST is more profitable at higher milk prices than at lower prices, resulting in higher rates of bST use and even higher milk supplies.

Because of the very high returns in the Southeast, more productive dairy capital is allowed to move into this region from surrounding regions and, thus, cow and farm numbers rise 0.4 percent annually both with and without bST (figs. 44 and 45). Rates of decline in other regions are very modest, ranging from 0.1 percent annually in the Corn Belt to 1.0 percent in the Northeast with bST. Without bST, exit rates are slightly faster than with bST because of lower profitability but are lower than other scenarios overall. Structural changes in each region favor larger farms with or without bST.

Figure 42

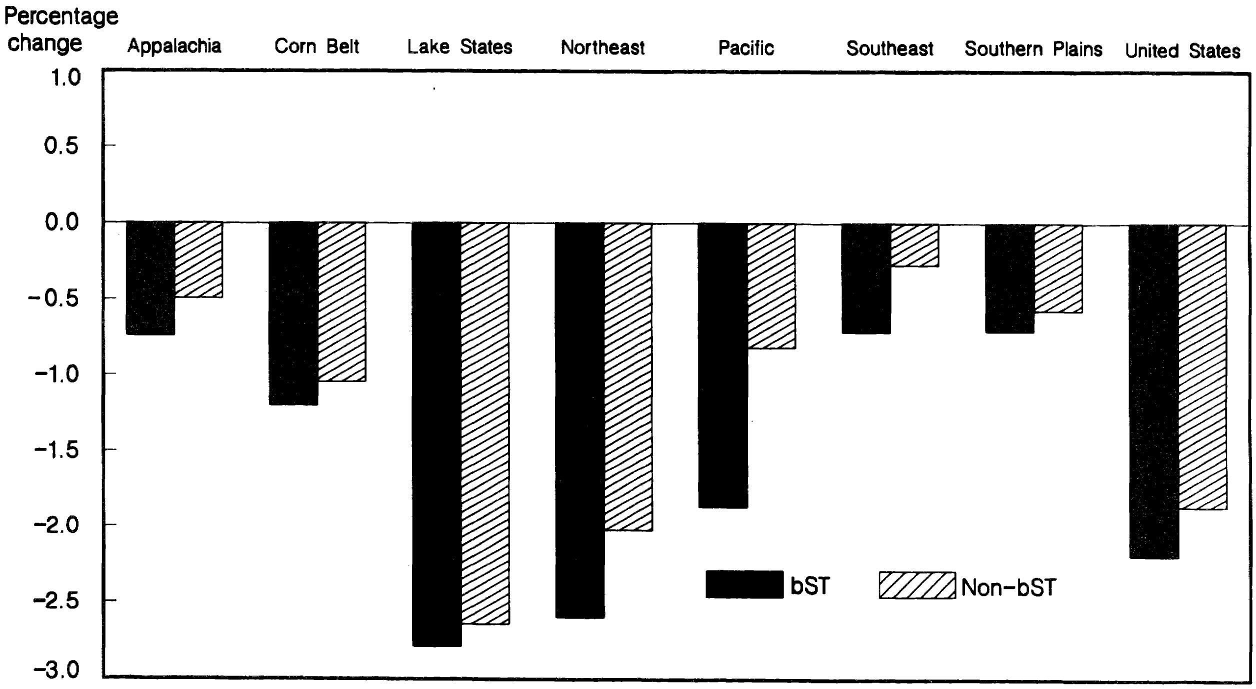
Scenario III: Annual average change in dairy cow numbers by region, 1986-96[1]



1/ Minimum $8.60 support price.

Figure 43

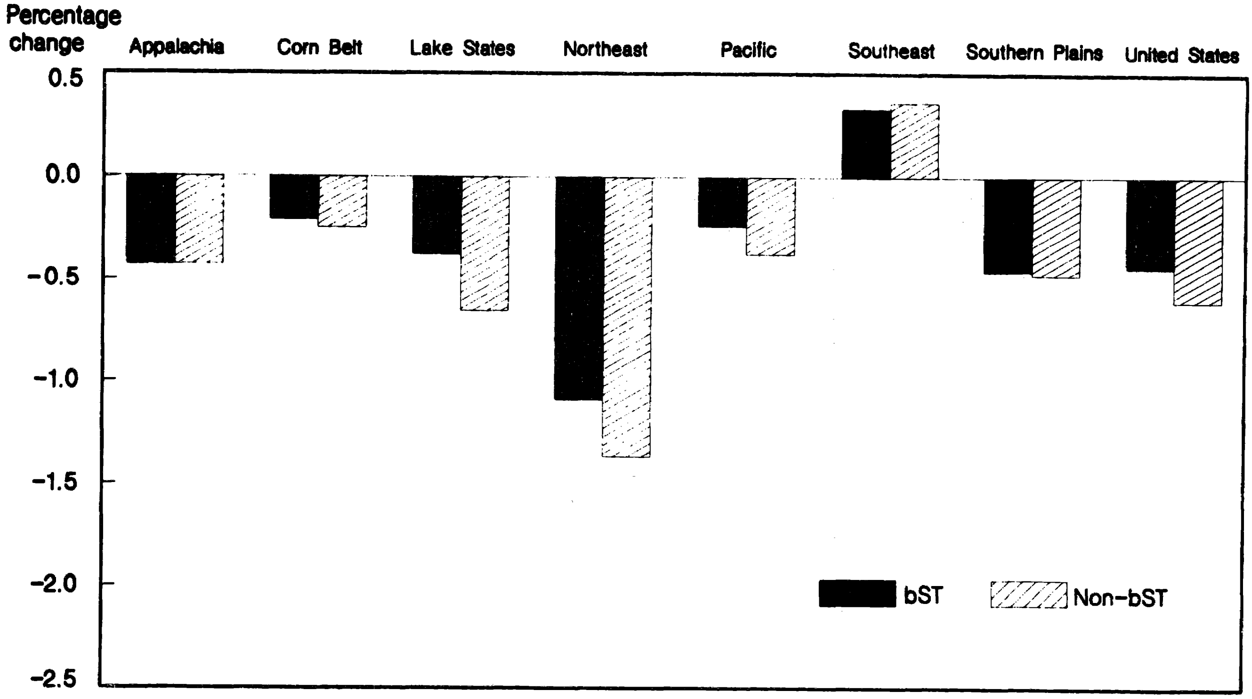
Scenario III: Annual average change in dairy farm numbers by region, 1986-96[1]



1/ Minimum $8.60 support price.

Figure 44

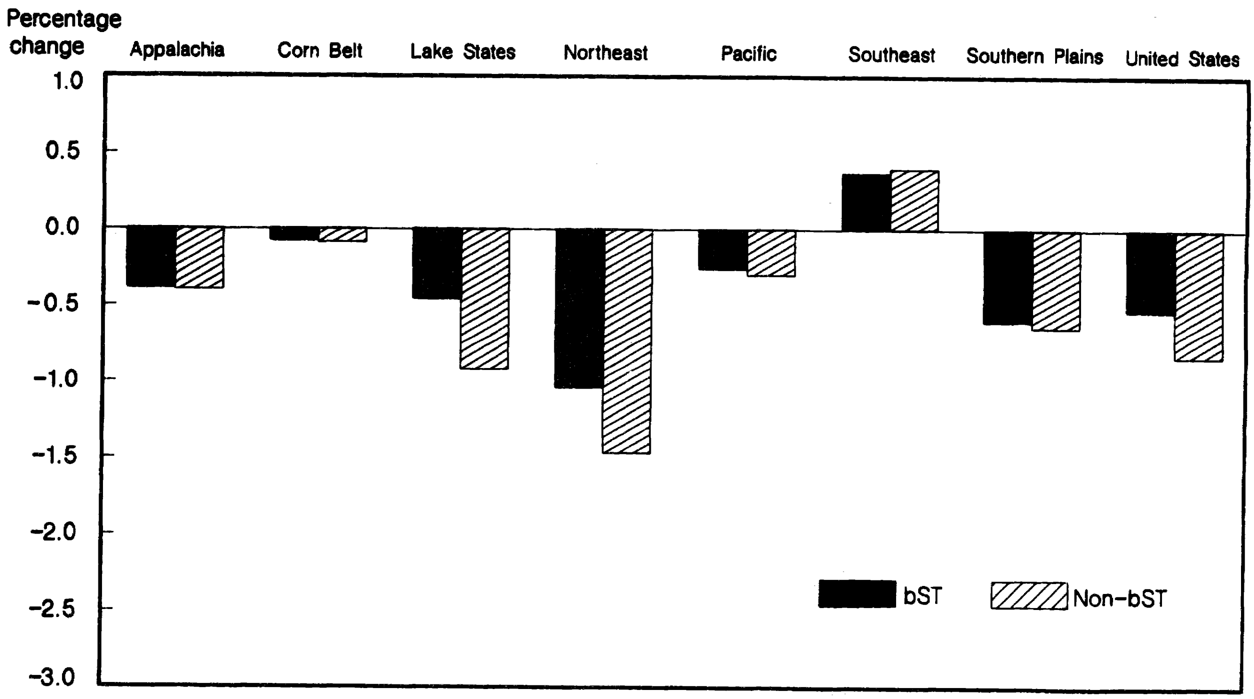
Scenario IV: Annual average change in dairy cow numbers by region, 1986-96[1]



1/ Minimum $11.10 support price.

Figure 45

Scenario IV: Annual average change in dairy farm numbers by region, 1986-96[1]



1/ Minimum $11.10 support price.

Chapter IX

International Implications of bST

Use of bST under current international trade rules would have little effect on U.S. competitiveness in the world dairy market. Dairy products are one of the most protected commodities in international trade. Almost every major developed dairy country has government programs regulating their dairy industries. Most subsidize part of or all domestic production. They often restrict imports and subsidize exports. Thus, the international dairy market bears little resemblence to a freely operating market. Without substantial changes in international trade policies or lowering U.S. dairy product import restrictions, bST would have little effect on U.S. competitiveness in world dairy markets. But if quotas, levies, tariffs, and other trade barriers were reduced or dismantled (that is, a change to a free trade environment), a delay in the adoption of bST could hurt the U.S. competitive position. Such changes would put the United States at a considerable disadvantage if bST were used in competing countries but not in the United States.

To delay or prohibit availability and adoption of new cost-reducing technologies like bST is dangerous for any country if other countries permit its use. Canada, Australia, New Zealand, the European Community (EC), and other countries, as well as the United States, are researching bST. The timeframe for likely approval of bST for commercial use in any country is uncertain.

Dairy trade is small relative to world milk production. About one-third of the world's milk is consumed as fresh milk and does not enter international trade. Another one-third is processed into butter. Much of the remaining one-third is processed into cheese, with the rest used in other food products or animal feed. About 10-15 percent of world butter production, 4-6 percent of cheese production, 20-25 percent of nonfat dry milk production, and 50-65 percent of casein is traded in international markets, excluding trade within the EC (intra-EC trade). High dairy price supports in many countries have stimulated production, leading to subsidized exports of dairy product surpluses. However, even with subsidized exports, world trade, excluding intra-EC trade, amounts to about 5 percent of world milk production, a market less than half as large as the U.S. domestic market.

Although U.S. prices for dairy products are roughly the same as domestic prices in most major dairy countries at current exchange rates, they are 2-3 times higher than current world market prices. Hence, restrictive import controls are used to prevent low-cost, subsidized dairy products from entering the U.S. market and undercutting the U.S. price support program. With imports curtailed to about 3 percent of U.S. consumption of manufactured dairy products, consumers pay more for all dairy products than they would under a less restrictive system. Section 22 of the Agricultural Adjustment Act of 1933 authorizes import quotas. Under Section 22, only the President can impose, adjust, or eliminate quotas, based ordinarily on the findings and recommendations of the International Trade Commission (ITC).

In recent years, exports of the three major dairy products (butter, cheese, and nonfat dry milk) have been primarily from countries with high domestic support prices, especially the EC but also from other Western European countries, Canada, and the United States. These exports have essentially been disposal of surpluses on the world market.

Relative milk production costs are one measure of competitiveness among countries. A 1981 USDA study applied budgeting techniques to secondary data to assess the relative costs of producing milk in countries that exported casein to the United States (see table 5).

The United States ranks seventh in milk production costs, but when dairy product shipping and handling charges are included in the costs, the United States can compete with all countries studied except New Zealand and Australia for the U.S. domestic market. New Zealand and Australia had milk production costs of $4.27 and $5.68 per cwt. Costs in Ireland, France, Argentina, West Germany, and the Netherlands ranged from $6.73 to $9.78 per cwt compared with $8.77 for the United States (table 5).

There is no indication that relative costs of milk production among countries have changed substantially in recent years. Thus, Austin's 1981 study evaluating 1978 data is still relevant.

Table 5--Milk production costs in selected countries, 1978

Country	Cost per cwt	Index	Rank
	U.S. dollars	Average = 100	
New Zealand	4.27	58	1
Australia	5.68	77	2
Ireland	6.73	91	3
France	7.68	104	4
Argentina	7.75	105	5
West Germany	8.51	115	6
United States	8.77	119	7
Netherlands	9.78	132	8
Average	7.40	100	NA

NA = Not applicable.

Source: Lynn A. Austin, "Costs of Milk Production in Seven Major Milk Protein Exporting Countries and the United States," Staff Report AGES810922. Econ. Res. Serv., U.S. Dept. Agr., 1981.

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Appendix I

Major Components and Tax Calculations of the Dairy Simulation Model

Appendix I mathematically describes the major components and tax calculations of the dairy simulation model. The components of the dairy simulation model are divided into three major categories: herd dynamics, cash flow, and tax effects.

HERD DYNAMICS

The herd dynamics component of the model tracks the number of producing cows by age cohort. Purchased cows (P) and cows raised onfarm are segregated for tax purposes. For purchased cows, a specific age cohort at time t+1 is determined by:

$$P^{i+1}_{t+1} = P^{i}_{t} * (1-d^{i}) * (1-c^{i}), \tag{1}$$

where i is the cohort age, t is time, d^i is the death rate, and c^i is the cull rate for that cohort. The equation for raised cows (R) is identical to the equation for purchased cows. The total herd (TH) at time t is the sum of purchased and raised cow cohorts.

Raised replacements are divided into three cohorts: the number of female calves, the number of first-year heifers, and the number of bred heifers. Female calves are a function of the producing herd:

$$Y^{0}_{t} = TH_{t} * 0.5 * (1-d). \tag{2}$$

The number of first-year heifers is:

$$Y^{1}_{t} = Y^{0}_{t} * (1-d^{0}) * (1-c^{0}). \tag{3}$$

The number of bred heifers is:

$$BH_{t+1} = Y^{1}_{t} * (1-d^{1}) * (1-b^{1}), \tag{4}$$

where Y^0 is female calves, Y^1 is heifers aged 0–1 year kept for replacements, BH is bred heifers, and b is the percentage of breeding failures.

The number of raised replacements entering the herd is the minimum of the number of cows needed to maintain desired herd size, or the number of successfully bred 2-year-old heifers (BH). The number of animals (N) needed to maintain herd size (HS) is:

$$N_{t+1} = HS - TH_{t} * (1-d) * (1-c). \tag{5}$$

Raised replacements entering the herd is then:

$$R^{1}_{t+1} = \min(BH_{t+1}, N_{t+1}). \tag{6}$$

Newly purchased cows make up the difference if the number of raised replacements are insufficient to maintain herd size, that is:

$$P^{0}_{t+1} = N_{t+1} - R^{1}_{t+1}. \tag{7}$$

The exogenous parameters of herd size, cull rates for specific cohorts, and death rates determine the entire herd dynamics for equations (1)–(7).

CASH FLOW

The components of the cash flow section are capital expenditures, financing of capital expenditures, operating revenues and expenses, and operating loans.

Capital expenditures for equipment and structures occur at multiples of their respective useful lives. The herd dynamics component determines purchases of new or replacement cows. All capital outlays for equipment and structures are indexed according to a general inflation index. Cattle purchases are indexed according to a specific cattle index.

To finance capital expenditures, the dairy simulation model uses constant principal payment loans. Cattle are financed with 5–year loans; equipment, 7–year loans; and structures and land, 20–year loans. Owner capital outlays in a given year are the sum of downpayments for new assets and principal payments for existing financed assets. The financial equations are made up of the following equations. The original principal (OP) is a moving sum of financed capital expenditures for the previous j years.

$$OP^{j}_{t} = \sum_{k=1}^{j} \sum_{l=1}^{l} FEX^{j,l}_{t-k}, \tag{8}$$

and

$$FEX^{j,l}_{t} = OPP^{j,l}_{t} * (1-f^{j}), \tag{9}$$

where FEX is the original loan amount on (l) financed assets with the same repayment terms of j years, OPP is the original purchase price, and f is the percentage downpayment. Principal payment (PP) at time t is the original principal divided by the loan term j:

$$PP^{j}_{t} = OP^{j}_{t}/j. \tag{10}$$

The beginning principal (BP) at the start of each year t for loans of j duration is:

$$BP_{t+1}^{j} = BP_{t}^{j} - PP_{t}^{j} + \sum_{l=1}^{L} FEX_{t}^{l,j}. \quad (11)$$

Interest expenses (INT) result from outstanding principal (OP) times the interest rate (IR):

$$INT_{t}^{j} = BP_{t}^{j} * IR^{j}. \quad (12)$$

Total capital outlays (TC), the sum of downpayments and principal payments on outstanding loans, is:

$$TC_{t} = \sum_{j} PP_{t} + \sum_{j} \sum_{l=1}^{L} FEX_{t}^{l,j} * f^{j}. \quad (13)$$

Operating Revenues and Expenses

Milk sales are a function of the herd size, age distribution of the herd, an index-adjusted milk price, and productivity index that includes adjustments for bST.

$$MS_{t} = MP * I_{t} * PD_{t} * \sum_{i=1}^{N} (P^{i} + R^{i}) * MY * Y(i), \quad (14)$$

where MS is milk sales; MP is base milk price; I is a milk price index, which is not limited to the fixed compounding rate, but rather, any series can be used; PD is a productivity index that reflexes genetic increases and the adoption of new technologies, such as bST; MY is base milk production level per cow; and Y(i) is an age adjustment factor for the productivity of different cow cohorts.

Cull sales (CS) are a function of the number and age distribution of the herd:

$$CS_{t} = CP * BI_{t} * (P_{t}^{i} + R_{t}^{i}) * c^{i}, \quad (15)$$

where CP is the base price of cull cows, and BI is a beef price index. The equations for cull calves and youngstock are similar formulations. The major operating expense of the dairy is feed. The dairy simulation model calculates the per-cow feed intake of forage (FO) and grain (GR) based on average milk production per cow (AP) *(11)*.

$$FO_{t} = f(AP_{t}) \text{ and } GR_{t} = g(AP_{t}). \quad (16)$$

Total feed costs (FC) for the producing herd is:

$$FC_{t} = TH_{t} * F_{t} * (FP_{t} * FO_{t} + GP_{t} * GR_{t}), \quad (17)$$

where FP is the base forage price, F is the feed price index, and GP is the base grain price.

Other operating expenses (milk hauling, Government payments, and utilities) are linear functions of total milk production and are indexed to the general inflation rate. Labor, insurance, supplies, breeding, property taxes, and DHIA testing are linear functions of herd size and also indexed to the inflation rate. bST administration costs are included in a miscellaneous category.

Net cash flow before borrowing (operating loans) is total sales of milk and culls minus operating expenses, taxes (calculated in the following section), and capital outlays and personal withdrawals. If the dairy has a negative cash flow in a given year, an operating loan withdrawal covers the cash flow deficit. The operating debt (OD) is:

$$OD_{t+1} = OD_t + LW_t - LP_t, \tag{18}$$

where LW is loan withdrawals, and LP is loan payments. Loan withdrawals are equal to the absolute value of negative net cash flows. Loan payments depend on a positive net cash position after making payments to accumulated interest. Accumulated interest (AI) is:

$$AI_{t+1} = AI_t + r * (OD_t + AI_t) - IP_t, \tag{19}$$

where r is the operating loan interest rate, and IP is payments to accumulated interest. Payments to interest are:

$$IP_t = \min(NCP_t, AI_t), \tag{20}$$

where NCP is net cash position before borrowing. Payments to principal are:

$$LP_t = \min(NCP_t - IP_t, OD_t). \tag{21}$$

TAX EFFECTS

Tax estimation follows the same sequence of calculation as IRS Form 1040. The sequence is as follows:

- o Calculate annual depreciation using both the Accelerated Cost Recovery System (ACRS) and straight-line methods.
- o Categorize the disposition of assets as ordinary or long-term gains or losses.
- o Calculate capital gains or losses, exclusions, and carryforward.
- o Calculate net farm income.
- o Calculate gross individual income and estimate carryforward of net operating losses.
- o Calculate tax liability before credits or other taxes.
- o Estimate other business credits.
- o Estimate social security taxes.

- o Estimate alternative minimum taxes.

- o Derive final tax liability.

The depreciation factor for equipment is a function of the age of the asset (the difference between year of purchase, t', and the current year, t) and the type of asset, 1. For accelerated depreciation under the 1986 Tax Reform Act, total equipment depreciation in year t is:

$$DEP_t = \sum_{t'=1}^{t} \sum_{1=1}^{L} BASIS_{t'}^{1} * a^{1}(t-t'), \tag{22}$$

where DEP is total depreciation, BASIS is the basis of the type of asset (1). The depreciation factor (a) is derived from new tax codes under the Tax Reform Act. To calculate the alternative minimum tax under the Tax Reform Act, accelerated depreciation must be compared with straight-line depreciation. Straight-line depreciation is also calculated using equation (22), except straight-line factors (s) are substituted for depreciation factors (a). Depreciation of cattle (a 5-year asset) is a function of the age cohort and the depreciation factor for that cohort. Under the Tax Reform Act, raised livestock have an established nonzero basis when they enter the producing herd. Cattle depreciation is determined as follows:

$$CDEP_t = \sum_{i=1}^{N} (P_t^i * PB_{t'}^i * a^i) + \sum_{i=1}^{N} (R_t^i * RB_{t'}^i * a^i), \tag{23}$$

where CDEP is cattle depreciation, PB is the original basis of cattle at the time of purchase, and RB is the established basis for purchased cattle at time t' when the cattle enter the herd.

The dairy simulation model classifies all assets for capital gains purposes by the length of time the assets are held. When the assets are disposed of, the model calculates long-term and ordinary gains and losses from the sale price, adjusted basis, and book value of the assets. Several rules and assumptions govern the classification of long-term gains and losses:

- o Dairy cattle must be held for a minimum of 2 years before the assets are considered long-term.

- o The Tax Reform Act requires that all youngstock be capitalized, thus when raised replacements enter the herd, they have a positive basis.

- o All used equipment and facilities are assumed to be fully depreciated when sold for salvage.

- o All assets are used in trade or business and, thus, are classified as Section 1231 property, subject to the capital gains-ordinary loss rule.

- o Dairy livestock and equipment are subject to section 1245 recapture.

For purchased livestock held more than 2 years, one of the following equations holds:

$$\text{if } (OPB_{t'}^i > SALE_t^i > BOOK_t^i) \text{ then } OGL_t^i = SALE_t^i - BOOK_t^i, \tag{24}$$

$$\text{if } (SALE_t^i < BOOK_t^i) \text{ then } OGL_t^i = BOOK_t^i - SALE_t^i, \tag{25}$$

$$\text{if } (SALE_t^i > OPB_t^i) \text{ then } LTG^i = SALE^i - BASIS^i, \tag{26}$$

where OPB is original basis adjusted for investment tax credit at time of purchase (t'), SALE is the sale price of the livestock (death is considered a sale with zero receipts), OGL is ordinary gain or loss, LTG is long-term gain, and BOOK is the adjusted basis after depreciation:

$$BOOK_t^i = OPB_{t'}^i * \prod_{j=1}^{t-t'} (1-a^j). \tag{27}$$

$$OPB_{t'}^i = OPB_{t'}^i - 0.5 * ITC, \tag{28}$$

where ITC is the amount of investment credit taken on assets (0 for the Tax Reform Act).

For purchased livestock held less than 2 years, equation (29) calculates ordinary gains or losses:

$$OGL_t^i = SALE_t^i - BOOK_t^i. \tag{29}$$

Under the Tax Reform Act, the producer must establish a basis for breeding animals from all costs, including prorated fixed and labor expenses, starting at conception. Bock *(4)* has noted that the IRS will probably establish average annual costs for raising dairy livestock because of the extensive accounting procedure necessary. Once the basis is established for raised livestock, the same rules for purchased livestock concerning capital gains sale and depreciation apply. Before a long-term capital gain is allowed on Section 1231 property, the prior 5 years of ordinary losses is subject to recapture, thus:

$$TLTG_t = \sum_{i=1}^{N} LTG_t^i - \sum_{j=1}^{5} NROL_{t-j} \quad \text{where } TLTG_t > 0, \tag{30}$$

where TLTG is total long-term capital gain allowed for year t (TLTG is only defined for positive values), LTG is the long-term gains of (N) individual assets, and NROL are nonrecaptured net ordinary losses from the prior 5 years. Long-term gains used to recapture previous ordinary losses (ROGL) are reported as ordinary gains in the current year:

$$\text{if } (\sum_i LTG_t^i < \sum_{j=1}^{5} NROL_{t-j}) \text{ then } ROGL_t = \sum_{i-1}^{N} LTG_i. \tag{31}$$

Nonrecaptured ordinary losses (NROL) are subsequently reduced by recapture in chronological order (see Bock *(4)* for a more complete explanation):

$$\sum_{j=1}^{5} NROL'_{t-j} = \sum_{j=1}^{5} NROL_{t-j} - ROGL_t, \tag{32}$$

where NRTOL' is the revised nonrecaptured losses.

Total ordinary gains and losses (TOGL) for the dairy in year (t) are:

$$TOGL_t = \sum_{k=1}^{R} OGL_k = ROGL_t, \tag{33}$$

where k is an index for R assets that are classified as ordinary gains or losses (OGL).

Calculation of Total and Adjusted Gross Income

The calculation of total income follows the sequential process of Form 1040, lines 7–22, using net operating losses (NOL's) from previous years. Total income (TI) is calculated as follows:

$$TI_t = W_t + CD_t * TLTG_t + OGL_t + FI_t + NOL_t, \tag{34}$$

where W is wages and salaries, CD is the capital gains rate, FI is farm income, and NOL is accumulated net operating losses from prior years (a negative amount). Adjusted gross income (AGI) from Form 1040 is assumed to be equal to total income; that is, there are no adjustments to income.

Farm income is defined as the sale of all nonasset commodities (milk, calves, and heifers kept less than 2 years) minus operating expenses, depreciation, and interest charges. Under the Tax Reform Act, the cost of raising dairy livestock is not a deductible expense. The dairy simulation model adds an estimated annual cost per animal unit times the number of heifers aged 0–1 and 1–2 years.

Net Operating Losses

Net operating losses result from negative total income calculated without the capital gains or other nonbusiness deductions. If total income is negative, net operating losses will accumulate for 15 years. Positive total income reduces the accumulated net operating losses:

$$NOL_{t+1} = FI_t + OGL_t + TLTG_t + W_t + NOL_t, \tag{35}$$

and

$$NOL_t < 0. \tag{36}$$

Because of the alternative minimum tax, total income and net operating losses are recalculated using straight-line depreciation. These variables are called modified total income (MTI) and modified net operating loss (MNOL).

Unadjusted Tax Liability

The dairy simulation model subtracts two personal exemptions from adjusted gross income to calculate taxable income and unadjusted tax liability. No excess itemized deductions are assumed. Under the Tax Reform Act, a standard deduction of $5,000 replaces the zero bracket amount (1988 and later). After 1989, the standard deduction is indexed for inflation. The single personal exemption is raised to $2,000 and indexed for inflation after 1990. The marginal tax brackets for the Tax Reform Act are complicated by transition rates, the phaseout of personal exemptions, and the 15-percent tax rate for high incomes (see Bock *(4)* for a complete description of these procedures). In this analysis, the Tax Reform Act is assumed to be fully implemented using the 1990 procedures. The following table outlines the tax brackets and marginal rates for the Tax Reform Act:

Taxable income	Tax rate	Comments
Dollars	*Percent*	
0–29,750	15	
29,750–71,980	28	
71,980–149,250	33	Phaseout of 15-percent tax rate
149,250–171,650	33	Phaseout of two personal exemptions
171,650 and over	28	

Source: *(4)*.

The Tax Reform Act, as opposed to the Economic Recovery Tax Act (ERTA), is inflation neutral. All bracket levels, exemptions, and the standard deduction are indexed to the inflation rate. The dairy simulation model calculates taxes under the Tax Reform Act in real terms, then adjusts the tax amount by an inflation index.

Credits and Other Taxes

Credits and other taxes reduce or increase the unadjusted tax liability. The major credit for the farm enterprise under ERTA is the investment tax credit (ITC). The Tax Reform Act repeals ITC; the model has no credit adjustments of tax liabilities.

Three additional taxes add to the final tax liability: social security, alternative minimum, and investment credit recapture taxes. Social security taxes are 7.15 percent of positive net farm income but are limited to a maximum of $3,003. Investment credit recapture taxes reduce the amount of business credit taken. If the recapture exceeds business credit, then recapture taxes are:

$$RT_t = RITC_t - BC_t \qquad (37)$$

The Tax Reform Act changes the alternative minimum tax in several ways. It increases the tax rate to 21 percent, phases out the $40,000 exemption for income exceeding $150,000, and limits the amount by which net operating losses can reduce the alternative minimum tax to 90 percent *(4)*. To calculate the minimum taxes requires that the modified total income be redefined to exclude net operating losses:

$$MTI = MTI + MNOL. \qquad (38)$$

(Because MTI was originally defined by subtracting MNOL, the above addition cancels out the effect of MNOL). The phase out of the exemption (PO) is:

$$PO_t = 0.25 * (MTI_t - 150{,}000) \text{ for } 310{,}000 > MTI_t > 150{,}000. \tag{39}$$

The alternative minimum tax without NOL's (AMT') is then:

$$AMT' = \min(0.21 * (MTI - (40000 + PO), TAC. \tag{40}$$

Equations (38) and (39) are then used, including MNOL as originally calculated, to determine AMT". The reported alternative minimum tax is then:

$$AMT = \min(AMT' * 0.1, AMT"). \tag{41}$$

Appendix II

Costs and Returns Budgets

Appendix tables 1–14 present the detailed costs and returns budgets for the range of response levels used in this study. It includes the per–cwt and per–cow budgets referred to in Chapter VI for the United States and six milk–producing regions.

Appendix table 1—United States: Effects of bST on milk production costs per cow, 1986

Item	Daily milk production response						
	No bST	3 lbs	5 lbs	8.4 lbs.	10 lbs	20 lbs	30 lbs
				Percent			
Response, overall lactation	NA	4.4	7.3	12.2	14.5	29.1	43.6
				Cwt			
Milk per cow	147.77	154.27	158.57	165.77	169.27	190.77	212.27
				Dollars			
Cash receipts:							
Milk	1,834.18	1,916.03	1,969.44	2,058.86	2,102.33	2,369.36	2,636.39
Cull cows	137.18	137.18	137.18	137.18	137.18	137.18	137.18
Total	1,971.36	2,053.21	2,106.62	2,196.04	2,239.51	2,506.54	2,773.57
Cash expenses:							
Feed--							
Silage	42.06	42.06	42.06	42.06	42.06	42.06	42.06
Concentrates	467.12	488.03	501.86	525.01	536.27	605.42	674.57
Hay	103.58	101.61	100.31	98.12	97.06	90.54	84.01
Pasture and other forages	4.83	4.83	4.83	4.83	4.83	4.83	4.83
Haylage	26.24	26.24	26.24	26.24	26.24	26.24	26.24
Total, feed expenses	643.83	662.77	675.30	696.26	706.46	769.09	831.71
Other--							
Milk hauling	48.47	50.91	52.33	54.70	55.86	62.95	70.05
Artificial insemination	17.34	17.34	17.34	17.34	17.34	17.34	17.34
Veterinary and medicine	31.26	31.26	31.26	31.26	31.26	31.26	31.26
Livestock hauling	2.47	2.47	2.47	2.47	2.47	2.47	2.47
Marketing	15.61	15.43	15.86	16.58	16.93	19.08	21.23
Fuel, lube, electricity	31.65	31.65	31.65	31.65	31.65	31.65	31.65
Machinery and building repairs	51.36	51.36	51.36	51.36	51.36	51.36	51.36
Hired labor	131.42	132.89	132.89	132.89	132.89	132.89	132.89
DHIA fees	7.66	7.66	7.66	7.66	7.66	7.66	7.66
Dairy supplies	25.35	25.35	25.35	25.35	25.35	25.35	25.35
Dairy assessment	53.20	55.54	57.09	59.68	60.94	68.68	76.42
Total, variable expenses	1,059.62	1,084.63	1,100.56	1,127.20	1,140.17	1,219.78	1,299.39
Total, fixed expenses	299.46	299.46	299.46	299.46	299.46	299.46	299.46
Total, cash expenses	1,359.08	1,384.09	1,400.02	1,426.66	1,439.63	1,519.24	1,598.85
Receipts less cash expenses	612.28	669.12	706.60	769.38	799.88	987.30	1,174.72
Capital replacement	210.74	210.74	210.74	210.74	210.74	210.74	210.74
Receipts less expenses and replacement	401.54	458.38	495.86	558.64	589.14	776.56	963.98
Cash margin for bST expense	NA	56.84	94.32	157.10	187.60	375.02	562.44
Break-even cost per treatment 1/	NA	8.12	13.47	22.44	26.80	53.57	80.35
bST selling price if 2:1 net return 1/	NA	2.71	4.49	7.48	8.93	17.86	26.78

NA = Not applicable.
1/ Seven monthly treatments.

Appendix table 2--United States: Effects of bST on milk production costs per cwt, 1986

Item	Daily milk production response						
	No bST	3 lbs	5 lbs	8.4 lbs	10 lbs	20 lbs	30 lbs
	Dollars						
Cash receipts:							
Milk	12.42	12.42	12.42	12.42	12.42	12.42	12.42
Cull cows	.94	.89	.87	.83	.81	.72	.65
Total	13.36	13.31	13.29	13.25	13.23	13.14	13.07
Cash expenses:							
Feed--							
Silage	.29	.27	.27	.25	.25	.22	.20
Concentrates	3.16	3.16	3.16	3.17	3.17	3.17	3.18
Hay	.67	.66	.63	.59	.57	.47	.40
Pasture and other forages	.03	.03	.03	.03	.03	.03	.02
Haylage	.18	.17	.17	.16	.16	.14	.12
Total, feed expenses	4.33	4.29	4.26	4.20	4.18	4.03	3.92
Other--							
Milk hauling	.33	.33	.33	.33	.33	.33	.33
Artificial insemination	.12	.11	.11	.10	.10	.09	.08
Veterinary and medicine	.21	.20	.20	.19	.18	.16	.15
Livestock hauling	.02	.02	.02	.01	.01	.01	.01
Marketing	.10	.10	.10	.10	.10	.10	.10
Fuel, lube, electricity	.22	.21	.20	.19	.19	.17	.15
Machinery and building repairs	.35	.33	.32	.31	.30	.27	.24
Hired labor	.88	.86	.84	.80	.79	.70	.63
DHIA fees	.05	.05	.05	.05	.05	.04	.04
Dairy supplies	.17	.16	.16	.15	.15	.13	.12
Dairy assessment	.36	.36	.36	.36	.36	.36	.36
Total, variable expenses	7.14	7.02	6.95	6.79	6.74	6.39	6.13
Total, fixed expenses	2.04	1.94	1.89	1.81	1.77	1.57	1.41
Total, cash expenses	9.18	8.96	8.84	8.60	8.51	7.96	7.54
Receipts less cash expenses	4.18	4.35	4.45	4.65	4.72	5.18	5.53
Capital replacement	1.46	1.37	1.33	1.27	1.24	1.10	.99
Receipts less expenses and replacement	2.72	2.98	3.12	3.38	3.48	4.08	4.54
Cash margin for bST expense	NA	.26	.40	.66	.76	1.36	1.82
Break-even milk price	12.42	12.16	12.02	11.76	11.66	11.06	10.60
Total, economic costs	11.70	11.31	11.10	10.71	10.64	9.85	9.23
Residual return to management and risk	1.66	2.00	2.19	2.54	2.59	3.29	3.84
True break-even milk price 1/	10.76	10.42	10.23	9.88	9.83	9.13	8.58

NA = Not applicable.

1/ Milk price that leaves the return to management and risk at zero dollars.

Appendix table 3—Appalachia: Effects of bST on milk production costs per cow, 1986

Item	Daily milk production response					
	No bST	3 lbs	5 lbs	10 lbs	20 lbs	30 lbs
				Percent		
Response, overall lactation	NA	4.5	7.4	14.8	29.6	44.4
				Cwt		
Milk per cow	145.31	151.81	156.11	166.81	188.31	209.81
				Dollars		
Cash receipts:						
Milk	1,921.44	2,005.41	2,062.21	2,203.56	2,487.58	2,771.59
Cull cows	116.14	116.14	116.14	116.14	116.14	116.14
Total	2,037.58	2,121.55	2,178.35	2,319.70	2,603.72	2,887.73
Cash expenses:						
Feed--						
Silage	92.95	92.95	92.95	92.95	92.95	92.95
Concentrates	550.75	573.70	588.88	626.66	702.56	778.47
Hay	89.49	86.84	85.08	80.72	71.95	63.18
Pasture and other forages	17.43	17.43	17.43	17.43	17.43	17.43
Haylage	18.57	18.57	18.57	18.57	18.57	18.57
Total, feed expenses	769.19	789.49	802.91	836.33	903.46	970.60
Other--						
Milk hauling	70.24	74.39	76.49	81.74	92.27	102.81
Artificial insemination	17.31	17.31	17.31	17.31	17.31	17.31
Veterinary and medicine	25.23	25.23	25.23	25.23	25.23	25.23
Livestock hauling	1.40	1.40	1.40	1.40	1.40	1.40
Marketing	19.74	21.25	21.86	23.35	26.36	29.37
Fuel, lube, electricity	30.00	30.00	30.00	30.00	30.00	30.00
Machinery and building repairs	43.70	43.70	43.70	43.70	43.70	43.70
Hired labor	172.18	173.57	173.57	173.57	173.57	173.57
DHIA fees	7.91	7.91	7.91	7.91	7.91	7.91
Dairy supplies	32.65	32.65	32.65	32.65	32.65	32.65
Dairy assessment	52.31	54.65	56.20	60.05	67.79	75.53
Total, variable expenses	1,241.86	1,271.55	1,289.23	1,333.24	1,421.65	1,510.08
Total, fixed expenses	259.05	259.05	259.05	259.05	259.05	259.05
Total, cash expenses	1,500.91	1,530.60	1,548.28	1,592.29	1,680.70	1,769.13
Receipts less cash expenses	536.67	590.95	630.07	727.41	923.02	1,118.60
Capital replacement	197.46	197.46	197.46	197.46	197.46	197.46
Receipts less expenses and replacement	339.21	393.49	432.61	529.95	725.56	921.14
Cash margin for bST expense	NA	54.28	93.40	190.74	386.35	581.93
Break-even cost per treatment 1/	NA	7.75	13.34	27.25	55.19	83.13
bST selling price if 2:1 net return 1/	NA	2.58	4.45	9.08	18.40	27.71

NA = Not applicable.
1/ Seven monthly treatments.

Appendix table 4--Appalachia: Effects of bST on milk production costs per cwt, 1986

Item	Daily milk production response					
	No bST	3 lbs	5 lbs	10 lbs	20 lbs	30 lbs
	Dollars					
Cash receipts:						
Milk	13.21	13.21	13.21	13.21	13.21	13.21
Cull cows	.80	.77	.74	.70	.62	.55
Total	14.01	13.98	13.95	13.91	13.83	13.76
Cash expenses:						
Feed--						
Silage	.63	.61	.60	.56	.49	.44
Concentrates	3.81	3.78	3.77	3.76	3.73	3.71
Hay	.62	.57	.55	.48	.38	.30
Pasture and other forages	.12	.11	.11	.10	.09	.08
Haylage	.13	.12	.12	.11	.10	.09
Total, feed expenses	5.31	5.19	5.15	5.01	4.79	4.62
Other--						
Milk hauling	.49	.49	.49	.49	.49	.49
Artificial insemination	.12	.11	.11	.10	.09	.08
Veterinary and medicine	.17	.17	.16	.15	.13	.12
Livestock hauling	.01	.01	.01	.01	.01	.01
Marketing	.14	.14	.14	.14	.14	.14
Fuel, lube, electricity	.21	.20	.19	.18	.16	.14
Machinery and building repairs	.30	.29	.28	.26	.23	.21
Hired labor	1.18	1.14	1.11	1.04	.92	.83
DHIA fees	.05	.05	.05	.05	.04	.04
Dairy supplies	.23	.22	.21	.20	.17	.16
Dairy assessment	.36	.36	.36	.36	.36	.36
Total, variable expenses	8.57	8.37	8.26	7.99	7.53	7.20
Total, fixed expenses	1.80	1.71	1.66	1.55	1.38	1.23
Total, cash expenses	10.37	10.08	9.92	9.54	8.91	8.43
Receipts less cash expenses	3.64	3.90	4.03	4.37	4.92	5.33
Capital replacement	1.36	1.30	1.26	1.18	1.05	.94
Receipts less expenses and replacement	2.28	2.60	2.77	3.19	3.87	4.39
Cash margin for bST expense	NA	.32	.49	.91	1.59	2.11
Break-even milk price	13.21	12.89	12.72	12.30	11.62	11.10
Total, economic costs	12.74	12.32	12.09	11.58	10.73	10.05
Residual return to management and risk	1.27	1.66	1.86	2.33	3.10	3.71
True break-even milk price 1/	11.94	11.55	11.35	10.88	10.11	9.50

NA = Not applicable.

1/ Milk price that leaves the return to management and risk at zero dollars.

Appendix table 5—Corn Belt: Effects of bST on milk production costs per cow, 1986

Item	Daily milk production response					
	No bST	3 lbs	5 lbs	10 lbs	20 lbs	30 lbs
			Percent			
Response, overall lactation	NA	4.6	7.6	15.2	30.3	45.5
			Cwt			
Milk per cow	141.82	148.32	152.62	163.32	184.82	206.32
			Dollars			
Cash receipts:						
Milk	1,741.58	1,819.89	1,872.65	2,003.94	2,267.74	2,531.55
Cull cows	128.60	128.60	128.60	128.60	128.60	128.60
Total	1,870.18	1,948.49	2,001.25	2,132.54	2,396.34	2,660.15
Cash expenses:						
Feed--						
Silage	29.18	29.18	29.18	29.18	29.18	29.18
Concentrates	486.43	507.13	520.82	554.89	623.36	691.82
Hay	63.71	62.30	61.37	59.06	54.40	49.75
Pasture and other forages	7.07	7.07	7.07	7.07	7.07	7.07
Haylage	26.56	26.56	26.56	26.56	26.56	26.56
Total, feed expenses	612.95	632.24	645.00	676.76	740.57	804.38
Other--						
Milk hauling	64.39	66.74	68.68	73.49	83.17	92.84
Artificial insemination	18.11	18.11	18.11	18.11	18.11	18.11
Veterinary and medicine	30.89	30.89	30.89	30.89	30.89	30.89
Livestock hauling	1.60	1.60	1.60	1.60	1.60	1.60
Marketing	15.13	16.32	16.79	17.97	20.33	22.70
Fuel, lube, electricity	40.68	40.68	40.68	40.68	40.68	40.68
Machinery and building repairs	57.47	57.47	57.47	57.47	57.47	57.47
Hired labor	93.67	95.14	95.14	95.14	95.14	95.14
DHIA fees	8.01	8.01	8.01	8.01	8.01	8.01
Dairy supplies	25.64	25.64	25.64	25.64	25.64	25.64
Dairy assessment	51.05	53.40	54.94	58.80	66.54	74.28
Total, variable expenses	1,019.59	1,046.24	1,062.95	1,104.56	1,188.15	1,271.74
Total, fixed expenses	285.29	285.29	285.29	285.29	285.29	285.29
Total, cash expenses	1,304.88	1,331.53	1,348.24	1,389.85	1,473.44	1,557.03
Receipts less cash expenses	565.30	616.96	653.01	742.69	922.90	1,103.12
Capital replacement	239.95	239.95	239.95	239.95	239.95	239.95
Receipts less expenses and replacement	325.35	377.01	413.06	502.74	682.95	863.17
Cash margin for bST expense	NA	51.66	87.71	177.39	357.60	537.82
Break-even cost per treatment 1/	NA	7.38	12.53	25.34	51.09	76.83
bST selling price if 2:1 net return 1/	NA	2.46	4.18	8.45	17.03	25.61

NA = Not applicable.

1/ Seven monthly treatments.

Appendix table 6—Corn Belt: Effects of bST on milk production costs per cwt, 1986

Item	No bST	3 lbs	5 lbs	10 lbs	20 lbs	30 lbs
	Daily milk production response					
	Dollars					
Cash receipts:						
Milk	12.27	12.27	12.27	12.27	12.27	12.27
Cull cows	.91	.87	.84	.79	.70	.62
Total	13.18	13.14	13.11	13.06	12.97	12.89
Cash expenses:						
Feed--						
Silage	.20	.20	.19	.18	.16	.14
Concentrates	3.43	3.42	3.41	3.40	3.37	3.35
Hay	.45	.42	.40	.36	.29	.24
Pasture and other forages	.05	.05	.05	.04	.04	.03
Haylage	.19	.18	.17	.16	.14	.13
Total, feed expenses	4.32	4.27	4.22	4.14	4.00	3.89
Other--						
Milk hauling	.45	.45	.45	.45	.45	.45
Artificial insemination	.13	.12	.12	.11	.10	.09
Veterinary and medicine	.22	.21	.20	.19	.17	.15
Livestock hauling	.01	.01	.01	.01	.01	.01
Marketing	.11	.11	.11	.11	.11	.11
Fuel, lube, electricity	.29	.27	.27	.25	.22	.20
Machinery and building repairs	.41	.39	.38	.35	.31	.28
Hired labor	.67	.64	.62	.58	.51	.46
DHIA fees	.06	.05	.05	.05	.04	.04
Dairy supplies	.18	.17	.17	.16	.14	.12
Dairy assessment	.36	.36	.36	.36	.36	.36
Total, variable expenses	7.21	7.05	6.96	6.76	6.42	6.16
Total, fixed expenses	2.00	1.92	1.87	1.75	1.54	1.38
Total, cash expenses	9.21	8.97	8.83	8.51	7.96	7.54
Receipts less cash expenses	3.97	4.17	4.28	4.55	5.01	5.35
Capital replacement	1.69	1.62	1.57	1.47	1.30	1.16
Receipts less expenses and replacement	2.28	2.55	2.71	3.08	3.71	4.19
Cash margin for bST expense	NA	.27	.43	.80	1.43	1.91
Break-even milk price	12.27	12.00	11.84	11.47	10.84	10.36
Total, economic costs	12.69	12.31	12.07	11.53	10.64	9.94
Residual return to management and risk	.49	.83	1.04	1.53	2.33	2.95
True break-even milk price 1/	11.78	11.44	11.23	10.74	9.94	9.32

NA = Not applicable.
1/ Milk price that leaves the return to management and risk at zero dollars.

Appendix table 7--Northeast: Effects of bST on milk production costs per cow, 1986

Item	Daily milk production response					
	No bST	3 lbs	5 lbs	10 lbs	20 lbs	30 lbs
				Percent		
Response, overall lactation	NA	4.4	7.3	14.4	28.9	43.3
				Cwt		
Milk per cow	148.89	155.39	159.69	170.39	191.89	213.39
				Dollars		
Cash receipts:						
Milk	1,894.06	1,976.56	2,031.26	2,167.36	2,440.84	2,714.32
Cull cows	132.13	132.13	132.13	132.13	132.13	132.13
Total	2,026.19	2,108.69	2,163.39	2,299.49	2,572.97	2,846.45
Cash expenses:						
Feed--						
Silage	50.11	50.11	50.11	50.11	50.11	50.11
Concentrates	490.44	513.36	528.52	566.25	642.06	717.87
Hay	60.26	58.07	56.62	53.01	45.75	38.48
Pasture and other forages	3.54	3.54	3.54	3.54	3.54	3.54
Haylage	25.76	25.76	25.76	25.76	25.76	25.76
Total, feed expenses	630.11	650.84	664.55	698.67	767.22	835.76
Other--						
Milk hauling	54.13	55.94	57.49	61.34	69.08	76.82
Artificial insemination	19.57	19.57	19.57	19.57	19.57	19.57
Veterinary and medicine	36.53	36.53	36.53	36.53	36.53	36.53
Livestock hauling	2.09	2.09	2.09	2.09	2.09	2.09
Marketing	17.07	17.09	17.57	18.74	21.11	23.47
Fuel, lube, electricity	34.03	34.03	34.03	34.03	34.03	34.03
Machinery and building repairs	49.18	49.18	49.18	49.18	49.18	49.18
Hired labor	171.14	172.67	172.67	172.67	172.67	172.67
DHIA fees	8.02	8.02	8.02	8.02	8.02	8.02
Dairy supplies	24.72	24.72	24.72	24.72	24.72	24.72
Dairy assessment	53.60	55.94	57.49	61.34	69.08	76.82
Total, variable expenses	1,100.19	1,126.62	1,143.91	1,186.90	1,273.30	1,359.68
Total, fixed expenses	259.18	259.18	259.18	259.18	259.18	259.18
Total, cash expenses	1,359.37	1,385.80	1,403.09	1,446.08	1,532.48	1,618.86
Receipts less cash expenses	666.82	722.89	760.30	853.41	1,040.49	1,227.59
Capital replacement	220.28	220.28	220.28	220.28	220.28	220.28
Receipts less expenses and replacement	446.54	502.61	540.02	633.13	820.21	1,007.31
Cash margin for bST expense	NA	56.07	93.48	186.59	373.67	560.77
Break-even cost per treatment 1/	NA	8.01	13.35	26.66	53.38	80.11
bST selling price if 2:1 net return 1/	NA	2.67	4.45	8.89	17.79	26.70

NA = Not applicable.
1/ Seven monthly treatments.

Appendix table 8--Northeast: Effects of bST on milk production costs per cwt, 1986

Item	Daily milk production response					
	No bST	3 lbs	5 lbs	10 lbs	20 lbs	30 lbs
	Dollars					
Cash receipts:						
Milk	12.72	12.72	12.72	12.72	12.72	12.72
Cull cows	.89	.85	.83	.78	.69	.62
Total	13.61	13.57	13.55	13.50	13.41	13.34
Cash expenses:						
Feed--						
Silage	.34	.32	.31	.29	.26	.23
Concentrates	3.30	3.30	3.31	3.32	3.35	3.36
Hay	.40	.37	.35	.31	.24	.18
Pasture and other forages	.02	.02	.02	.02	.02	.02
Haylage	.17	.17	.16	.15	.13	.12
Total, feed expenses	4.23	4.18	4.15	4.09	4.00	3.91
Other--						
Milk hauling	.36	.36	.36	.36	.36	.36
Artificial insemination	.13	.13	.12	.11	.10	.09
Veterinary and medicine	.25	.24	.23	.21	.19	.17
Livestock hauling	.01	.01	.01	.01	.01	.01
Marketing	.11	.11	.11	.11	.11	.11
Fuel, lube, electricity	.23	.22	.21	.20	.18	.16
Machinery and building repairs	.33	.32	.31	.29	.26	.23
Hired labor	1.15	1.11	1.08	1.01	.90	.81
DHIA fees	.05	.05	.05	.05	.04	.04
Dairy supplies	.17	.16	.15	.15	.13	.12
Dairy assessment	.36	.36	.36	.36	.36	.36
Total, variable expenses	7.38	7.25	7.14	6.95	6.64	6.37
Total, fixed expenses	1.73	1.67	1.62	1.52	1.35	1.21
Total, cash expenses	9.11	8.92	8.76	8.47	7.99	7.58
Receipts less cash expenses	4.50	4.65	4.79	5.03	5.42	5.76
Capital replacement	1.49	1.42	1.38	1.29	1.15	1.03
Receipts less expenses and replacement	3.01	3.23	3.41	3.74	4.27	4.73
Cash margin for bST expense	NA	.22	.40	.73	1.26	1.72
Break-even milk price	12.72	12.50	12.32	11.99	11.46	11.00
Total, economic costs	12.14	11.82	11.61	11.13	10.33	9.70
Residual return to management and risk	1.47	1.75	1.94	2.37	3.08	3.64
True break-even milk price 1/	11.25	10.97	10.78	10.35	9.64	9.08

NA = Not applicable.
1/ Milk price that leaves the return to management and risk at zero dollars.

Appendix table 9—Pacific: Effects of bST on milk production costs per cow, 1986

Item	Daily milk production response					
	No bST	3 lbs	5 lbs	10 lbs	20 lbs	30 lbs
			Percent			
Response, overall lactation	NA	3.7	6.1	12.1	24.3	36.4
			Cwt			
Milk per cow	176.98	183.48	187.78	198.48	219.98	241.48
			Dollars			
Cash receipts:						
Milk	2,093.84	2,170.57	2,221.44	2,348.02	2,602.36	2,856.71
Cull cows	123.29	123.29	123.29	123.29	123.29	123.29
Total	2,217.13	2,293.86	2,344.73	2,471.31	2,725.65	2,980.00
Cash expenses:						
Feed--						
Silage	20.38	20.38	20.38	20.38	20.38	20.38
Concentrates	520.99	541.27	554.69	588.08	655.17	722.27
Hay	314.52	312.20	310.67	306.85	299.18	291.49
Pasture and other forages	4.20	4.20	4.20	4.20	4.20	4.20
Haylage	15.97	15.97	15.97	15.97	15.97	15.97
Total, feed expenses	876.06	894.02	905.91	935.48	994.90	1,054.31
Other--						
Milk hauling	52.20	53.21	54.46	57.56	63.79	70.03
Artificial insemination	18.79	18.79	18.79	18.79	18.79	18.79
Veterinary and medicine	24.57	24.57	24.57	24.57	24.57	24.57
Livestock hauling	1.91	1.91	1.91	1.91	1.91	1.91
Marketing	24.92	25.69	26.29	27.79	30.80	33.81
Fuel, lube, electricity	21.30	21.30	21.30	21.30	21.30	21.30
Machinery and building repairs	64.37	64.37	64.37	64.37	64.37	64.37
Hired labor	164.79	166.65	166.65	166.65	166.65	166.65
DHIA fees	9.33	9.33	9.33	9.33	9.33	9.33
Dairy supplies	27.19	27.19	27.19	27.19	27.19	27.19
Dairy assessment	63.71	66.05	67.60	71.45	79.19	86.93
Total, variable expenses	1,349.14	1,373.08	1,388.37	1,426.39	1,502.79	1,579.19
Total, fixed expenses	232.74	232.74	232.74	232.74	232.74	232.74
Total, cash expenses	1,581.88	1,605.82	1,621.11	1,659.13	1,735.53	1,811.93
Receipts less cash expenses	635.25	688.04	723.62	812.18	990.12	1,168.07
Capital replacement	121.08	121.08	121.08	121.08	121.08	121.08
Receipts less expenses and replacement	514.17	566.96	602.54	691.10	869.04	1,046.99
Cash margin for bST expense	NA	52.79	88.37	176.93	354.87	532.82
Break-even cost per treatment 1/	NA	7.54	12.62	25.28	50.70	76.12
bSt selling price if 2:1 net return 1/	NA	2.51	4.21	8.43	16.90	25.37

NA = Not applicable.
1/ Seven monthly treatments.

Appendix table 10—Pacific: Effects of bST on milk production costs per cwt, 1986

Item	Daily milk production response					
	No bST	3 lbs	5 lbs	10 lbs	20 lbs	30 lbs
	Dollars					
Cash receipts:						
Milk	11.83	11.83	11.83	11.83	11.83	11.83
Cull cows	.70	.67	.66	.62	.56	.51
Total	12.53	12.50	12.49	12.45	12.39	12.34
Cash expenses:						
Feed--						
Silage	.11	.11	.11	.10	.09	.08
Concentrates	2.95	2.95	2.95	2.96	2.98	2.99
Hay	1.78	1.70	1.65	1.55	1.36	1.21
Pasture and other forages	.02	.02	.02	.02	.02	.02
Haylage	.09	.09	.09	.08	.07	.07
Total, feed expenses	4.95	4.87	4.82	4.71	4.52	4.37
Other--						
Milk hauling	.29	.29	.29	.29	.29	.29
Artificial insemination	.11	.10	.10	.09	.09	.08
Veterinary and medicine	.14	.13	.13	.12	.11	.10
Livestock hauling	.01	.01	.01	.01	.01	.01
Marketing	.14	.14	.14	.14	.14	.14
Fuel, lube, electricity	.12	.12	.11	.11	.10	.09
Machinery and building repairs	.36	.35	.34	.32	.29	.27
Hired labor	.93	.91	.89	.84	.76	.69
DHIA fees	.05	.05	.05	.05	.04	.04
Dairy supplies	.15	.15	.14	.14	.12	.11
Dairy assessment	.36	.36	.36	.36	.36	.36
Total, variable expenses	7.61	7.48	7.38	7.18	6.83	6.55
Total, fixed expenses	1.31	1.27	1.24	1.17	1.06	.96
Total, cash expenses	8.92	8.75	8.62	8.35	7.89	7.51
Receipts less cash expenses	3.61	3.75	3.87	4.10	4.50	4.83
Capital replacement	.68	.66	.64	.61	.55	.50
Receipts less expenses and replacement	2.93	3.09	3.23	3.49	3.95	4.33
Cash margin for bST expense	NA	.16	.30	.56	1.02	1.40
Break-even milk price	11.83	11.67	11.53	11.27	10.81	10.43
Total, economic costs	9.43	9.26	9.13	8.83	8.31	7.89
Residual return to management and risk	3.10	3.24	3.36	3.62	4.08	4.45
True break-even milk price 1/	8.73	8.59	8.47	8.21	7.75	7.38

NA = Not applicable.
1/ Milk price that leaves the return to management and risk at zero dollars.

Appendix table 11—Southern Plains: Effects of bST on milk production costs per cow, 1986

Item	Daily milk production response					
	No bST	3 lbs	5 lbs	10 lbs	20 lbs	30 lbs
			Percent			
Response, overall lactation	NA	4.4	7.4	14.7	29.4	44.1
			Cwt			
Milk per cow	146.17	152.67	156.97	167.67	189.17	210.67
			Dollars			
Cash receipts:						
Milk	1,995.27	2,083.95	2,142.64	2,288.70	2,582.17	2,875.65
Cull cows	118.20	118.20	118.20	118.20	118.20	118.20
Total	2,113.47	2,202.15	2,260.84	2,406.90	2,700.37	2,993.85
Cash expenses:						
Feed--						
Silage	6.45	6.45	6.45	6.45	6.45	6.45
Concentrates	555.89	576.50	590.13	624.06	692.23	760.40
Hay	207.06	204.46	202.74	198.46	189.86	181.24
Pasture and other forages	4.74	4.74	4.74	4.74	4.74	4.74
Haylage	11.33	11.33	11.33	11.33	11.33	11.33
Total, feed expenses	785.47	803.48	815.39	845.04	904.61	964.16
Other--						
Milk hauling	61.39	64.12	65.93	70.42	79.45	88.48
Artificial insemination	11.69	11.69	11.69	11.69	11.69	11.69
Veterinary and medicine	20.43	20.43	20.43	20.43	20.43	20.43
Livestock hauling	.85	.85	.85	.85	.85	.85
Marketing	29.23	30.53	31.39	33.53	37.83	42.13
Fuel, lube, electricity	25.24	25.24	25.24	25.24	25.24	25.24
Machinery and building repairs	24.40	24.40	24.40	24.40	24.40	24.40
Hired labor	160.85	162.25	162.25	162.25	162.25	162.25
DHIA fees	2.18	2.18	2.18	2.18	2.18	2.18
Dairy supplies	39.23	39.23	39.23	39.23	39.23	39.23
Dairy assessment	52.62	54.96	56.51	60.36	68.10	75.84
Total, variable expenses	1,213.58	1,239.36	1,255.49	1,295.62	1,376.26	1,456.88
Total, fixed expenses	288.79	288.79	288.79	288.79	288.79	288.79
Total, cash expenses	1,502.37	1,528.15	1,544.28	1,584.41	1,665.05	1,745.67
Receipts less cash expenses	611.10	674.00	716.56	822.49	1,035.32	1,248.18
Capital replacement	151.30	151.30	151.30	151.30	151.30	151.30
Receipts less expenses and replacement	459.80	522.70	565.26	671.19	884.02	1,096.88
Cash margin for bST expense	NA	62.90	105.46	211.39	424.22	637.08
Break-even cost per treatment 1/	NA	8.99	15.07	30.20	60.60	91.01
bSt selling price if 2:1 net return 1/	NA	3.00	5.02	10.07	20.20	30.34

NA = Not applicable.

1/ Seven monthly treatments.

Appendix table 12—Southern Plains: Effects of bST on milk production costs per cwt, 1986

Item	No bST	3 lbs	5 lbs	10 lbs	20 lbs	30 lbs
	Daily milk production response					
	Dollars					
Cash receipts:						
Milk	13.65	13.65	13.65	13.65	13.65	13.65
Cull cows	.81	.77	.75	.70	.62	.56
Total	14.46	14.42	14.40	14.35	14.27	14.21
Cash expenses:						
Feed--						
Silage	.04	.04	.04	.04	.03	.03
Concentrates	3.80	3.78	3.76	3.72	3.66	3.61
Hay	1.42	1.34	1.29	1.18	1.00	.86
Pasture and other forages	.03	.03	.03	.03	.03	.02
Haylage	.08	.07	.07	.07	.06	.05
Total, feed expenses	5.37	5.26	5.19	5.04	4.78	4.57
Other--						
Milk hauling	.42	.42	.42	.42	.42	.42
Artificial insemination	.08	.08	.07	.07	.06	.06
Veterinary and medicine	.14	.13	.13	.12	.11	.10
Livestock hauling	.01	.01	.01	.01	.00	.00
Marketing	.20	.20	.20	.20	.20	.20
Fuel, lube, electricity	.18	.17	.16	.15	.13	.12
Machinery and building repairs	.17	.16	.16	.15	.13	.12
Hired labor	1.10	1.06	1.03	.97	.86	.77
DHIA fees	.02	.01	.01	.01	.01	.01
Dairy supplies	.27	.26	.25	.23	.21	.19
Dairy assessment	.36	.36	.36	.36	.36	.36
Total, variable expenses	8.32	8.12	7.99	7.73	7.27	6.92
Total, fixed expenses	1.97	1.89	1.84	1.72	1.53	1.37
Total, cash expenses	10.29	10.01	9.83	9.45	8.80	8.29
Receipts less cash expenses	4.17	4.41	4.57	4.90	5.47	5.92
Capital replacement	1.04	.99	.96	.90	.80	.72
Receipts less expenses and replacement	3.13	3.42	3.61	4.00	4.67	5.20
Cash margin for bST expense	NA	.29	.48	.87	1.54	2.07
Break-even milk price	13.65	13.36	13.17	12.78	12.11	11.58
Total, economic costs	11.25	10.93	10.74	10.29	9.55	8.96
Residual return to management and risk	3.21	3.49	3.66	4.06	4.72	5.25
True break-even milk price 1/	10.44	10.16	9.99	9.59	8.93	8.40

NA = Not applicable.

1/ Milk price that leaves the return to management and risk at zero dollars.

Appendix table 13--Lake States: Effects of bST on milk production costs per cow, 1986

Item	Daily milk production response					
	No bST	3 lbs	5 lbs	10 lbs	20 lbs	30 lbs
			Percent			
Response, overall lactation	NA	4.7	7.8	15.5	31.0	46.5
			Cwt			
Milk per cow	138.61	145.11	149.41	160.11	181.61	203.11
			Dollars			
Cash receipts:						
Milk	1,683.73	1,763.09	1,815.33	1,945.34	2,206.56	2,467.79
Cull cows	155.74	155.74	155.74	155.74	155.74	155.74
Total	1,839.47	1,918.83	1,971.07	2,101.08	2,362.30	2,623.53
Cash expenses:						
Feed--						
Silage	38.93	38.93	38.93	38.93	38.93	38.93
Concentrates	394.63	413.85	426.56	458.20	521.76	585.33
Hay	62.03	60.41	59.34	56.68	51.34	45.97
Pasture and other forages	2.21	2.21	2.21	2.21	2.21	2.21
Haylage	33.68	33.68	33.68	33.68	33.68	33.68
Total, feed expenses	531.48	549.08	560.72	589.70	647.92	706.12
Other--						
Milk hauling	31.47	31.92	32.87	35.22	39.95	44.68
Artificial insemination	15.51	15.51	15.51	15.51	15.51	15.51
Veterinary and medicine	32.57	32.57	32.57	32.57	32.57	32.57
Livestock hauling	3.63	3.63	3.63	3.63	3.63	3.63
Marketing	8.86	8.71	8.96	9.61	10.90	12.19
Fuel, lube, electricity	32.09	32.09	32.09	32.09	32.09	32.09
Machinery and building repairs	50.83	50.83	50.83	50.83	50.83	50.83
Hired labor	88.15	89.46	89.46	89.46	89.46	89.46
DHIA fees	7.15	7.15	7.15	7.15	7.15	7.15
Dairy supplies	21.85	21.85	21.85	21.85	21.85	21.85
Dairy assessment	49.90	52.24	53.79	57.64	65.38	73.12
Total, variable expenses	873.49	895.04	909.43	945.26	1,017.24	1,089.20
Total, fixed expenses	375.63	375.63	375.63	375.63	375.63	375.63
Total, cash expenses	1,249.12	1,270.67	1,285.06	1,320.89	1,392.87	1,464.83
Receipts less cash expenses	590.35	648.16	686.01	780.19	969.43	1,158.70
Capital replacement	237.58	237.58	237.58	237.58	237.58	237.58
Receipts less expenses and replacement	352.77	410.58	448.43	542.61	731.85	921.12
Cash margin for bST expense	NA	57.81	95.66	189.84	379.08	568.35
Break-even cost per treatment 1/	NA	8.26	13.67	27.12	54.15	81.19
bST selling price if 2:1 net return 1/	NA	2.75	4.56	9.04	18.05	27.06

NA = Not applicable.
1/ Seven monthly treatments.

Appendix table 14—Lake States: Effects of bST on milk production costs per cwt, 1986

Item	Daily milk production response					
	No bST	3 lbs	5 lbs	10 lbs	20 lbs	30 lbs
	Dollars					
Cash receipts:						
Milk	12.15	12.15	12.15	12.15	12.15	12.15
Cull cows	1.13	1.07	1.04	.97	.86	.77
Total	13.28	13.22	13.19	13.12	13.01	12.92
Cash expenses:						
Feed--						
Silage	.28	.27	.26	.24	.21	.19
Concentrates	2.85	2.85	2.85	2.86	2.87	2.88
Hay	.45	.42	.40	.35	.28	.23
Pasture and other forages	.02	.02	.01	.01	.01	.01
Haylage	.25	.23	.23	.21	.19	.17
Total, feed expenses	3.85	3.79	3.75	3.67	3.56	3.48
Other--						
Milk hauling	.22	.22	.22	.22	.22	.22
Artificial insemination	.11	.11	.10	.10	.09	.08
Veterinary and medicine	.24	.22	.22	.20	.18	.16
Livestock hauling	.03	.03	.02	.02	.02	.02
Marketing	.06	.06	.06	.06	.06	.06
Fuel, lube, electricity	.23	.22	.21	.20	.18	.16
Machinery and building repairs	.37	.35	.34	.32	.28	.25
Hired labor	.64	.62	.60	.56	.49	.44
DHIA fees	.05	.05	.05	.04	.04	.04
Dairy supplies	.16	.15	.15	.14	.12	.11
Dairy assessment	.36	.36	.36	.36	.36	.36
Total, variable expenses	6.32	6.18	6.08	5.89	5.60	5.38
Total, fixed expenses	2.71	2.59	2.51	2.35	2.07	1.85
Total, cash expenses	9.03	8.77	8.59	8.24	7.67	7.23
Receipts less cash expenses	4.25	4.45	4.60	4.88	5.34	5.69
Capital replacement	1.72	1.64	1.59	1.48	1.31	1.17
Receipts, expenses and replacement	2.53	2.81	3.01	3.40	4.03	4.52
Cash margin for bST expense	NA	.28	.48	.87	1.50	1.99
Break-even milk price	12.15	11.87	11.67	11.28	10.65	10.16
Total, economic costs	11.74	11.34	11.11	10.60	9.74	9.06
Residual return to management and risk	1.54	1.88	2.08	2.52	3.27	3.86
True break-even milk price 1/	10.61	10.27	10.07	9.63	8.88	8.29

NA = Not applicable.
1/ Milk price that leaves the return to management and risk at zero dollars.

Appendix III
Results of the Industry and Farm-level Models

Appendix tables 15–22 present the results of the industry and farm-level models referred to in Chapter VII for cow numbers, per-cow and total production, the milk price, Government purchases, and commercial disappearance.

Appendix table 15--Scenario I ($10.10 support price): Cow numbers, production per cow, and total production with and without bST

Year	Without bST			With bST		
		Production			Production	
	Cow numbers	Per cow	Total	Cow numbers	Per cow	Total
	Thousands	Lbs/cow	Billion lbs	Thousands	Lbs/cow	Billion lbs
1989	10,444	13,870	144.8	10,444	13,870	144.8
1990	10,284	14,279	146.5	10,307	14,440	148.8
1991	10,078	14,696	147.4	10,138	15,004	152.1
1992	9,899	15,012	148.0	9,986	15,661	156.4
1993	9,760	15,225	148.6	9,853	16,041	158.1
1994	9,669	15,478	149.6	9,741	16,324	159.0
1995	9,605	15,729	151.0	9,635	16,624	160.2
1996	9,532	15,968	152.0	9,513	16,877	160.6

Appendix table 16--Scenario I ($10.10 support price): Milk price, Government purchases, and commercial disappearance with and without bST

Year	Without bST			With bST		
	Milk price	Government purchases	Commercial disappearance	Milk price	Government purchases	Commercial disappearance
	$/cwt	Billion lbs		$/cwt	Billion lbs	
1989	11.13	4.9	139.6	11.13	4.9	139.6
1990	11.21	5.3	141.1	11.06	7.4	141.0
1991	11.33	5.1	142.6	10.97	9.1	142.6
1992	11.41	4.2	144.0	10.86	11.8	144.2
1993	11.45	2.8	145.1	10.84	12.2	145.5
1994	11.48	2.6	146.5	10.86	11.8	146.8
1995	11.49	3.0	147.7	10.89	11.8	148.0
1996	11.50	2.9	148.9	10.95	11.0	149.2

Appendix table 17--Scenario II ($9.60 support price): Cow numbers, production per cow, and total production with and without bST

Year	Without bST			With bST		
		Production			Production	
	Cow numbers	Per cow	Total	Cow numbers	Per cow	Total
	Thousands	Lbs/cow	Billion lbs	Thousands	Lbs/cow	Billion lbs
1989	10,444	13,870	144.8	10,444	13,870	144.8
1990	10,283	14,251	146.5	10,254	14,439	148.0
1991	10,071	14,644	147.9	9,988	15,000	150.0
1992	9,897	15,010	148.3	9,809	15,653	153.4
1993	9,756	15,225	148.6	9,687	16,010	155.3
1994	9,642	15,477	149.2	9,585	16,313	156.6
1995	9,532	15,729	149.9	9,497	16,611	157.8
1996	9,403	15,968	150.1	9,394	16,851	158.4

Appendix table 18--Scenario II ($9.60 support price): Milk price, Government purchases, and commercial disappearance with and without bST

Year	Without bST			With bST		
	Milk price	Government purchases	Commercial disappearance	Milk price	Government purchases	Commercial disappearance
	$/cwt	Billion lbs		$/cwt	Billion lbs	
1989	11.13	4.9	139.6	11.13	4.9	139.6
1990	10.75	4.8	141.3	10.66	6.3	141.4
1991	10.86	4.5	142.6	10.64	6.6	142.8
1992	10.94	4.2	144.0	10.55	8.8	144.3
1993	11.01	2.9	145.2	10.53	9.1	145.6
1994	11.05	2.2	146.6	10.54	9.1	146.9
1995	11.10	1.6	147.9	10.56	9.1	148.3
1996	11.16	0.5	149.2	10.60	8.3	149.6

Appendix table 19—Scenario III ($8.60 support price): Cow numbers, production per cow, and total production with and without bST

Year	Without bST			With bST		
		Production			Production	
	Cow numbers	Per cow	Total	Cow numbers	Per cow	Total
	Thousands	Lbs/cow	Billion lbs	Thousands	Lbs/cow	Billion lbs
1989	10,444	13,870	144.8	10,444	13,870	144.8
1990	10,283	14,251	146.5	10,291	14,439	148.0
1991	10,071	14,644	147.9	10,063	15,000	150.0
1992	9,897	15,010	148.3	9,833	15,653	153.4
1993	9,756	15,225	148.6	9,616	16,003	153.8
1994	9,642	15,477	149.2	9,428	16,297	153.6
1995	9,532	15,729	149.9	9,261	16,538	153.2
1996	9,403	15,968	150.1	9,088	16,835	153.0

Appendix table 20—Scenario III ($8.60 support price): Milk price, Government purchases, and commercial disappearance with and without bST

Year	Without bST			With bST		
	Milk price	Government purchases	Commercial disappearance	Milk price	Government purchases	Commercial disappearance
	$/cwt	Billion lbs		$/cwt	Billion lbs	
1989	11.13	4.9	139.6	11.13	4.9	139.6
1990	10.75	4.8	141.3	10.63	6.3	141.4
1991	10.86	4.5	142.6	10.14	6.5	143.2
1992	10.94	4.2	144.0	9.77	8.3	144.8
1993	11.01	2.9	145.2	9.82	7.4	146.1
1994	11.05	2.2	146.6	9.91	5.9	147.4
1995	11.10	1.6	147.9	9.99	4.3	148.6
1996	11.16	0.5	149.2	10.10	2.8	149.9

Appendix table 21—Scenario IV ($11.10 support price): Cow numbers, production per cow, and total production with and without bST

Year	Without bST			With bST		
		Production			Production	
	Cow numbers	Per cow	Total	Cow numbers	Per cow	Total
	Thousands	Lbs/cow	Billion lbs	Thousands	Lbs/cow	Billion lbs
1989	10,577	14,208	150.3	10,577	14,208	150.3
1990	10,514	14,505	152.5	10,575	14,716	155.6
1991	10,397	14,731	153.2	10,555	15,327	161.8
1992	10,322	15,013	155.0	10,520	15,941	167.7
1993	10,280	15,233	156.6	10,497	16,358	171.7
1994	10,255	15,481	158.8	10,484	16,660	174.7
1995	10,227	15,734	160.9	10,439	16,916	176.6
1996	10,174	15,969	162.5	10,354	17,188	178.0

Appendix table 22—Scenario IV ($11.10 support price): Milk price, Government purchases, and commercial disappearance with and without bST

Year	Without bST			With bST		
	Milk price	Government purchases	Commercial disappearance	Milk price	Government purchases	Commercial disappearance
	$/cwt	Billion lbs		$/cwt	Billion lbs	
1989	12.40	13.3	136.6	12.40	13.3	136.6
1990	12.46	14.1	137.8	12.37	17.4	138.0
1991	12.52	13.3	139.4	12.41	22.0	139.5
1992	12.53	13.7	140.7	12.42	26.6	140.9
1993	12.50	13.9	142.2	12.41	29.1	142.3
1994	12.46	14.7	143.6	12.38	30.7	143.7
1995	12.44	15.4	145.0	12.35	31.2	145.1
1996	12.46	15.6	146.4	12.35	31.2	146.5

Appendix IV

Changes in Cow and Farm Numbers

Appendix tables 23–38 present the estimates of regional farm and cow number changes referred to in Chapter VIII.

Appendix table 23—Scenario I ($10.10 support price): Change in cow numbers with bST by region and farm size, 1986-96

Item	Cow numbers 1986	Removals	Additions	1996	Annual percentage change
	Number				Percent
Appalachia	769,374	41,032	14,361	742,703	-0.35
1-99 cows	438,863	22,617	0	416,246	-.52
100-199 cows	254,755	13,556	4,739	245,938	-.35
200 or more cows	75,756	4,859	9,622	80,519	.63
Corn Belt	1,366,364	167,789	58,726	1,257,301	-.80
1-99 cows	1,153,823	121,009	0	1,032,814	-1.05
100 or more cows	212,541	46,780	58,726	224,487	.56
Lake States	3,499,604	938,023	327,262	2,888,843	-1.75
1-99 cows	3,079,294	824,085	0	2,255,209	-2.68
100-199 cows	341,040	113,938	107,996	335,098	-.17
200 or more cows	79,270	0	219,266	298,536	27.66
Northeast	2,231,800	599,383	193,548	1,825,965	-1.82
1-49 cows	837,237	78,117	0	759,120	-.93
50-99 cows	898,748	391,956	0	506,792	-4.36
100-149 cows	255,396	58,820	64,516	261,092	.22
150-249 cows	146,479	43,212	64,516	167,783	1.45
250 or more cows	93,940	27,278	64,516	131,178	3.96
Pacific	1,865,439	216,616	75,816	1,724,639	-.76
1-249 cows	551,670	49,435	0	502,235	-.90
250-499 cows	590,596	54,420	37,908	574,084	-.28
500 or more cows	723,173	112,761	37,908	648,320	-1.04
Southeast	662,056	9,743	3,410	655,723	-.10
1-299 cows	275,248	9,743	0	265,505	-.35
200 or more cows	386,808	0	3,410	390,218	.09
Southern Plains	439,354	31,946	11,182	418,590	-.47
1-349 cows	347,237	25,248	5,591	327,580	-.57
350 or more cows	92,117	6,698	5,591	91,010	-.12
U.S. total	10,833,991	2,004,532	684,305	9,513,764	-1.22

Appendix table 24--Scenario I ($10.10 support price): Change in farm numbers with bST by region and farm size, 1986-96

Item	Farm numbers: 1986	Removals	Additions	1996	Annual percentage change
	Number				Percent
Appalachia	11,562	603	78	11,037	-0.45
1-99 farms	9,089	468	0	8,621	-.52
100-199 farms	2,178	116	41	2,102	-.35
200 or more farms	296	19	38	314	.63
Corn Belt	32,709	3,638	499	29,569	-.96
1-99 farms	30,904	3,241	0	27,663	-1.05
100 or more farms	1,805	397	499	1,906	.56
Lake States	67,067	18,047	1,798	50,817	-2.42
1-99 farms	63,926	17,108	0	46,818	-2.68
100-199 farms	2,812	939	890	2,763	-.17
200 or more farms	328	0	908	1,236	27.66
Northeast	49,759	10,645	1,383	40,496	-1.86
1-49 farms	30,028	2,802	0	27,226	-.93
50-99 farms	15,609	6,807	0	8,802	-4.36
100-149 farms	2,753	634	695	2,814	.22
150-249 farms	1,028	303	453	1,177	1.45
250 or more farms	341	99	234	477	3.96
Pacific	8,595	828	182	7,949	-.75
1-249 farms	5,622	504	0	5,119	-.90
250-499 farms	2,191	202	141	2,129	-.28
500 or more farms	782	122	41	701	-1.04
Southeast	2,848	78	6	2,777	-.25
1-299 farms	2,193	78	0	2,116	-.35
300 or more farms	655	0	6	661	.09
Southern Plains	2,460	179	49	2,330	-.53
1-349 farms	2,252	164	36	2,125	-.57
350 or more farms	208	15	13	205	-.12
U.S. total	175,000	34,019	3,994	144,975	-1.72

Appendix table 25--Scenario I ($10.10 support price): Change in cow numbers without bST by region and farm size, 1986-96

Item	Cow numbers				Annual percentage change
	1986	Removals	Additions	1996	
	Number				Percent
Appalachia	769,374	40,441	14,154	743,087	-0.34
1-99 cows	438,863	22,292	0	416,571	-.51
100-199 cows	254,755	13,361	4,671	246,065	-.34
200 or more cows	75,756	4,789	9,484	80,450	.62
Corn Belt	1,366,364	165,374	57,881	1,258,871	-.79
1-99 cows	1,153,823	119,268	0	1,034,555	-1.03
100 or more cows	212,541	46,107	57,881	224,315	.55
Lake States	3,499,604	924,523	322,552	2,897,633	-1.72
1-99 cows	3,079,294	812,225	0	2,267,069	-2.64
100-199 cows	341,040	112,298	106,442	335,184	-.17
200 or more cows	79,270	0	216,110	295,380	27.26
Northeast	2,231,800	590,757	190,763	1,831,806	-1.79
1-49 cows	837,237	76,993	0	760,244	-.92
50-99 cows	898,748	386,315	0	512,433	-4.30
100-149 cows	255,396	57,973	63,588	261,010	.22
150-249 cows	146,479	42,590	63,588	167,476	1.43
250 or more cows	93,940	26,885	63,588	130,642	3.91
Pacific	1,865,439	213,499	74,725	1,726,665	-.74
1-249 cows	551,670	48,724	0	502,946	-.88
250-499 cows	590,596	53,637	37,362	574,322	-.28
500 or more cows	723,173	111,138	37,362	649,397	-1.02
Southeast	662,056	9,603	3,361	655,814	-.09
1-299 cows	275,248	9,603	0	265,645	-.35
300 or more cows	386,808	0	3,361	390,169	.09
Southern Plains	439,354	31,486	11,021	418,889	-.47
1-349 cows	347,237	24,885	5,511	327,863	-.56
350 or more cows	92,117	6,602	5,511	91,026	-.12
U.S. total	10,833,991	1,975,684	674,457	9,532,764	-1.20

Appendix table 26—Scenario I ($10.10 support price): Change in farm numbers without bST by region and farm size, 1986-96

Item	Farm numbers				Annual percentage change
	1986	Removals	Additions	1996	
		Number			Percent
Appalachia	11,562	595	77	11,045	-0.45
1-99 farms	9,089	462	0	8,628	-.51
100-199 farms	2,178	114	40	2,103	-.34
200 or more farms	296	19	37	314	.62
Corn Belt	32,709	3,586	491	29,614	-.95
1-99 farms	30,904	3,194	0	27,709	-1.03
100 or more farms	1,805	392	491	1,905	.55
Lake States	67,067	17,788	1,773	51,051	-2.39
1-99 farms	63,926	16,862	0	47,065	-2.64
100-199 farms	2,812	926	878	2,764	-.17
200 or more farms	328	0	895	1,223	27.26
Northeast	49,759	10,492	1,363	40,629	-1.84
1-49 farms	30,028	2,761	0	27,266	-.92
50-99 farms	15,609	6,709	0	8,900	-4.30
100-149 farms	2,753	625	685	2,813	.22
150-249 farms	1,028	299	446	1,175	1.43
250 or more farms	341	98	231	475	3.91
Pacific	8,595	816	179	7,958	-.74
1-249 farms	5,622	497	0	5,126	-.88
250-499 farms	2,191	199	139	2,130	-.28
500 or more farms	782	120	40	702	-1.02
Southeast	2,848	77	6	2,778	-.25
1-299 farms	2,193	77	0	2,117	-.35
300 or more farms	655	0	6	661	.09
Southern Plains	2,460	176	48	2,332	-.52
1-349 farms	2,252	161	36	2,126	-.56
350 or more farms	208	15	12	205	-.12
U.S. total	175,000	33,529	3,937	145,408	-1.69

Appendix table 27—Scenario II ($9.60 support price): Change in cow numbers with bST by region and farm size, 1986-96

Item	Cow numbers 1986	Removals	Additions	1996	Annual percentage change
	Number				Percent
Appalachian	769,374	44,762	15,666	740,279	-0.38
1-99 cows	438,863	24,673	0	414,190	-.56
100-199 cows	254,755	14,788	5,170	245,137	-.38
200 or more cows	75,756	5,301	10,497	80,952	.69
Corn Belt	1,366,364	183,039	64,064	1,247,388	-.87
1-99 cows	1,153,823	132,008	0	1,021,815	-1.14
100 or more cows	212,541	51,032	64,064	225,573	.61
Lake States	3,499,604	1,023,283	357,007	2,833,327	-1.90
1-99 cows	3,079,294	898,989	0	2,180,305	-2.92
100-199 cows	341,040	124,294	117,812	334,557	-.19
200 or more cows	79,270	0	239,195	318,465	30.18
Northeast	2,231,800	653,862	211,139	1,789,076	-1.98
1-49 cows	837,237	85,217	0	752,020	-1.02
50-99 cows	898,748	427,582	0	471,166	-4.76
100-149 cows	255,396	64,166	70,380	261,609	.24
150-249 cows	146,479	47,140	70,380	169,719	1.59
250 or more cows	93,940	29,757	70,380	134,562	4.32
Pacific	1,865,439	236,304	82,707	1,711,841	-.82
1-249 cows	551,670	53,928	0	497,742	-.98
250-499 cows	590,596	59,366	41,353	572,583	-.31
500 or more cows	723,173	123,010	41,353	641,516	-1.13
Southeast	662,056	10,629	3,720	655,147	-.10
1-299 cows	275,248	10,629	0	264,619	-.39
300 or more cows	386,808	0	3,720	390,528	.10
Southern Plains	439,354	34,850	12,198	416,703	-.52
1-349 cows	347,237	27,543	6,099	325,793	-.62
350 or more cows	92,117	7,307	6,099	90,909	-.13
U.S. total	10,833,991	2,186,730	746,501	9,393,761	-1.33

Appendix table 28—Scenario II ($9.60 support price): Change in farm numbers with bST by region and farm size, 1986-96

Item	Farm numbers: 1986	Removals	Additions	1996	Annual percentage change
	Number				Percent
Appalachia	11,562	658	85	10,990	-0.50
1-99 farms	9,089	511	0	8,578	-.56
100-199 farms	2,178	126	44	2,095	-.38
200 or more farms	296	21	41	316	.69
Corn Belt	32,709	3,969	544	29,284	-1.05
1-99 farms	30,904	3,536	0	27,368	-1.14
100 or more farms	1,805	433	544	1,915	.61
Lake States	67,067	19,688	1,962	49,341	-2.64
1-99 farms	63,926	18,663	0	45,263	-2.92
100-199 farms	2,812	1,025	971	2,758	-.19
200 or more farms	328	0	991	1,319	30.18
Northeast	49,759	11,613	1,508	39,654	-2.03
1-49 farms	30,028	3,056	0	26,971	-1.02
50-99 farms	15,609	7,426	0	8,183	-4.76
100-149 farms	2,753	692	759	2,820	.24
150-249 farms	1,028	331	494	1,191	1.59
250 or more farms	341	108	256	489	4.32
Pacific	8,595	903	198	7,890	-.82
1-249 farms	5,622	550	0	5,073	-.98
250-499 farms	2,191	220	153	2,124	-.31
500 or more farms	782	133	45	694	-1.13
Southeast	2,848	85	6	2,770	-.28
1-299 farms	2,193	85	0	2,109	-.39
300 or more farms	655	0	6	662	.10
Southern Plains	2,460	195	53	2,318	-.58
1-349 farms	2,252	179	40	2,113	-.62
350 or more farms	208	16	14	205	-.13
U.S. total	175,000	37,111	4,357	142,246	-1.87

Appendix table 29—Scenario II ($9.60 support price): Change in cow numbers without bST by region and farm size, 1986-96

Item	Cow numbers 1986	Removals	Additions	1996	Annual percentage change
	Number				Percent
Appalachia	769,374	44,672	15,785	740,486	-0.38
1-99 cows	438,863	24,624	0	414,239	-.56
100-199 cows	254,755	14,759	5,209	245,205	-.38
200 or more cows	75,756	5,290	10,576	81,042	.70
Corn Belt	1,366,364	182,675	64,548	1,248,237	-.87
1-99 cows	1,153,823	131,745	0	1,022,078	-1.14
100 or more cows	212,541	50,930	64,548	226,159	.64
Lake States	3,499,604	1,021,242	359,705	2,838,066	-1.89
1-99 cows	3,079,294	897,196	0	2,182,098	-2.91
100-199 cows	341,040	124,046	118,702	335,696	-.16
200 or more cows	79,270	0	241,003	320,273	30.40
Northeast	2,231,800	652,559	212,735	1,791,976	-1.97
1-49 cows	837,237	85,047	0	752,190	-1.02
50-99 cows	898,748	426,730	0	472,018	-4.75
100-149 cows	255,396	64,038	70,912	262,269	.27
150-249 cows	146,479	47,046	70,912	170,345	1.63
250 or more cows	93,940	29,698	70,912	135,154	4.39
Pacific	1,865,439	235,834	83,332	1,712,937	-.82
1-249 cows	551,670	53,821	0	497,849	-.98
250-499 cows	590,596	59,248	41,666	573,014	-.30
500 or more cows	723,173	122,765	41,666	642,074	-1.12
Southeast	662,056	10,607	3,748	655,197	-.10
1-299 cows	275,248	10,607	0	264,641	-.39
300 or more cows	386,808	0	3,748	390,556	.10
Southern Plains	439,354	34,780	12,291	416,864	-.51
1-349 cows	347,237	27,488	6,145	325,894	-.62
350 or more cows	92,117	7,292	6,145	90,970	-.13
U.S. total	10,833,991	2,182,370	752,143	9,403,764	-1.32

Appendix table 30—Scenario II ($9.60 support price): Change in farm numbers without bST by region and farm size, 1986-96

Item	Farm numbers 1986	Removals	Additions	1996	Annual percentage change
	Number				Percent
Appalachia	11,562	657	86	10,991	-0.49
1-99 farms	9,089	510	0	8,579	-.56
100-199 farms	2,178	126	45	2,096	-.38
200 or more farms	296	21	41	316	.70
Corn Belt	32,709	3,961	548	29,296	-1.04
1-99 farms	30,904	3,529	0	27,375	-1.14
100 or more farms	1,805	432	548	1,920	.64
Lake States	67,067	19,649	1,977	49,395	-2.64
1-99 farms	63,926	18,626	0	45,301	-2.91
100-199 farms	2,812	1,023	979	2,768	-.16
200 or more farms	328	0	998	1,326	30.40
Northeast	49,759	11,590	1,520	39,689	-2.02
1-49 farms	30,028	3,050	0	26,977	-1.02
50-99 farms	15,609	7,411	0	8,198	-4.75
100-149 farms	2,753	690	764	2,827	.27
150-249 farms	1,028	330	498	1,195	1.63
250 or more farms	341	108	258	491	4.39
Pacific	8,595	901	200	7,894	-.82
1-249 farms	5,622	549	0	5,074	-.98
250-499 farms	2,191	220	155	2,125	-.30
500 or more farms	782	133	45	694	-1.12
Southeast	2,848	85	6	2,770	-.27
1-299 farms	2,193	85	0	2,109	-.38
300 or more farms	655	0	6	662	.10
Southern Plains	2,460	195	54	2,319	-.57
1-349 farms	2,252	178	40	2,114	-.62
350 or more farms	208	16	14	205	-.13
U.S. total	175,000	37,037	4,390	142,353	-1.87

Appendix table 31—Scenario III ($8.60 support price): Change in cow numbers with bST by region and farm size, 1986-96

Item	Cow numbers: 1986	Removals	Additions	1996	Annual percentage change
	Number				Percent
Appalachia	769,374	67,084	9,896	712,186	-0.74
1-99 cows	438,863	28,274	0	410,589	-.64
100-199 cows	254,755	25,611	0	229,144	-1.01
200 or more cows	75,756	13,199	9,896	72,453	-.44
Corn Belt	1,366,364	186,687	53,438	1,233,115	-.98
1-99 cows	1,153,823	152,681	0	1,001,142	-1.32
100 or more cows	212,541	34,006	53,438	231,973	.91
Lake States	3,499,604	1,006,435	236,198	2,729,367	-2.20
1-99 cows	3,079,294	925,328	0	2,153,966	-3.01
100-199 cows	342,040	81,107	45,003	304,936	-1.06
200 or more cows	79,270	0	191,195	270,465	24.12
Northeast	2,231,800	805,317	313,947	1,740,430	-2.20
1-49 cows	837,237	126,560	0	710,677	-1.51
50-99 cows	898,748	554,152	0	344,596	-6.17
100-149 cows	255,396	64,376	104,649	295,669	1.58
150-249 cows	146,479	36,922	104,649	214,206	4.62
250 or more cows	93,940	23,307	104,649	175,282	8.66
Pacific	1,865,439	401,091	146,456	1,610,804	-1.37
1-249 cows	551,670	132,728	0	418,942	-2.41
250-499 cows	590,596	120,245	73,228	543,576	-.80
500 or more cows	723,173	148,118	73,228	648,283	-1.04
Southeast	662,056	27,522	9,633	644,167	-.27
1-299 cows	275,248	27,522	0	247,726	-1.00
300 or more cows	386,808	0	9,633	396,441	.25
Southern Plains	439,354	33,025	8,651	414,980	-.56
1-349 cows	347,237	28,168	0	319,069	-.81
350 or more cows	92,117	4,857	8,651	95,911	.41
U.S. total	10,833,991	2,527,161	778,219	9,085,049	-1.61

Appendix table 32—Scenario III ($8.60 support price): Change in farm numbers with bST by region and farm size, 1986-96

Item	Farm numbers				Annual percentage change
	1986	Removals	Additions	1996	
		Number			Percent
Appalachia	11,563	856	62	10,769	-0.69
1-99 farms	9,089	586	0	8,503	-.64
100-199 farms	2,178	219	42	2,001	-.81
200 or more farms	296	52	19	264	-1.09
Corn Belt	32,709	4,378	454	28,785	-1.20
1-99 farms	30,904	4,089	0	26,815	-1.32
100 or more farms	1,805	289	454	1,970	.91
Lake States	67,066	19,879	1,162	48,350	-2.79
1-99 farms	63,926	19,210	0	44,716	-3.01
100-199 farms	2,812	669	371	2,514	-1.06
200 or more farms	328	0	791	1,119	24.12
Northeast	49,759	15,201	2,242	36,800	-2.60
1-49 farms	30,028	4,539	0	25,489	-1.51
50-99 farms	15,609	9,624	0	5,985	-6.17
100-149 farms	2,753	694	1,128	3,187	1.58
150-249 farms	1,028	259	734	1,503	4.62
250 or more farms	341	85	380	636	8.66
Pacific	8,595	1,959	351	6,987	-1.87
1-249 farms	5,622	1,353	0	4,269	-2.41
250-499 farms	2,191	446	272	2,017	-.80
500 or more farms	782	160	79	701	-1.04
Southeast	2,848	219	16	2,645	-.71
1-299 farms	2,193	219	0	1,974	-1.00
300 or more farms	655	0	16	671	.25
Southern Plains	2,460	194	20	2,286	-.71
1-349 farms	2,252	183	0	2,069	-.81
350 or more farms	208	11	20	217	.41
U.S. total	175,000	42,686	4,307	136,621	-2.19

Appendix table 33—Scenario III ($8.60 support price): Change in cow numbers without bST by region and farm size, 1986-96

Item	Cow numbers: 1986	Removals	Additions	1996	Annual percentage change
	Number				Percent
Appalachia	769,374	44,672	15,785	740,486	-0.38
1-99 cows	438,863	24,624	0	414,239	-.56
100-199 cows	254,755	14,759	5,209	245,205	-.38
200 or more cows	75,756	5,290	10,576	81,042	.70
Corn Belt	1,366,364	182,675	64,548	1,248,237	-.87
1-99 cows	1,153,823	131,745	0	1,022,078	-1.14
100 or more cows	212,541	50,930	64,548	226,159	.64
Lake States	3,499,604	1,021,242	359,705	2,838,066	-1.89
1-99 cows	3,079,294	897,196	0	2,182,098	-2.91
100-199 cows	341,040	124,046	118,702	335,696	-.16
200 or more cows	79,270	0	241,003	320,273	30.40
Northeast	2,231,800	652,559	212,735	1,791,976	-1.97
1-49 cows	837,237	85,047	0	752,190	-1.02
50-99 cows	898,748	426,730	0	472,018	-4.75
100-149 cows	255,396	64,038	70,912	262,269	.27
150-249 cows	146,479	47,046	70,912	170,345	1.63
250 or more cows	93,940	29,698	70,912	135,154	4.39
Pacific	1,865,439	235,834	83,332	1,712,937	-.82
1-249 cows	551,670	53,821	0	497,849	-.98
250-499 cows	590,596	59,248	41,666	573,014	-.30
500 or more cows	723,173	122,765	41,666	642,074	-1.12
Southeast	662,056	10,607	3,748	655,197	-.10
1-299 cows	275,248	10,607	0	264,641	-.39
300 or more cows	386,808	0	3,748	390,556	.10
Southern Plains	439,354	34,780	12,291	416,864	-.51
1-349 cows	347,237	27,488	6,145	325,894	-.62
350 or more cows	92,117	7,292	6,145	90,970	-.13
U.S. total	10,833,991	2,182,370	752,143	9,403,764	-1.32

Appendix table 34—Scenario III ($8.60 support price): Change in farm numbers without bST by region and farm size, 1986-96

Item	Farm numbers				Annual percentage change
	1986	Removals	Additions	1996	
	Number				Percent
Appalachia	11,562	657	86	10,991	-0.49
1-99 farms	9,089	510	0	8,579	-.56
100-199 farms	2,178	126	45	2,096	-.38
200 or more farms	296	21	41	316	.70
Corn Belt	32,709	3,961	548	29,296	-1.04
1-99 farms	30,904	3,529	0	27,375	-1.14
100 or more farms	1,805	432	548	1,920	.64
Lake States	67,067	19,649	1,977	49,395	-2.63
1-99 farms	63,926	18,626	0	45,301	-2.91
100-199 farms	2,812	1,023	979	2,768	-.16
200 or more farms	328	0	998	1,326	30.40
Northeast	49,759	11,590	1,520	39,689	-2.02
1-49 farms	30,028	3,050	0	26,977	-1.02
50-99 farms	15,609	7,411	0	8,198	-4.75
100-149 farms	2,753	690	764	2,827	.27
150-249 farms	1,028	330	498	1,195	1.63
250 or more farms	341	108	258	491	4.39
Pacific	8,595	901	200	7,894	-.82
1-249 farms	5,622	549	0	5,074	-.98
250-499 farms	2,191	220	155	2,125	-.30
500 or more farms	782	133	45	694	-1.12
Southeast	2,848	85	6	2,770	-.27
1-299 farms	2,193	85	0	2,109	-.38
300 or more farms	655	0	6	662	.10
Southern Plains	2,460	195	54	2,319	-.57
1-349 farms	2,252	178	40	2,114	-.61
350 or more farms	208	16	14	205	-.13
U.S. total	175,000	37,037	4,390	142,353	-1.87

Appendix table 35--Scenario IV ($11.10 support price): Change in cow numbers with bST by region and farm size, 1986-96

Item	Cow numbers 1986	Removals	Additions	1996	Annual percentage change
	Number				Percent
Appalachia	769,374	32,660	0	736,714	-0.43
1-99 cows	438,863	15,700	0	423,163	-.36
100-199 cows	254,755	13,073	0	241,682	-.51
200 or more cows	75,756	3,887	0	71,869	-.51
Corn Belt	1,366,364	29,247	0	1,337,117	-.21
1-99 cows	1,153,823	0	0	1,153,823	.00
100 or more cows	212,541	29,247	0	183,294	-1.38
Lake States	3,499,604	207,811	76,234	3,368,027	-.38
1-99 cows	3,079,294	145,452	0	2,933,842	-.47
100-199 cows	341,040	62,359	38,117	316,798	-.71
200 or more cows	79,270	0	38,117	117,387	4.81
Northeast	2,231,800	335,236	92,898	1,989,462	-1.09
1-49 cows	837,237	22,465	0	814,772	-.27
50-99 cows	898,748	250,096	0	648,652	-2.78
100-149 cows	255,396	30,930	0	224,466	-1.21
150-249 cows	146,479	19,460	46,449	173,468	1.84
250 or more cows	93,940	12,285	46,449	128,104	3.64
Pacific	1,865,439	75,257	29,840	1,820,022	-.24
1-249 cows	551,670	17,786	0	533,884	-.32
250-499 cows	590,596	19,579	14,920	585,937	-.08
500 or more cows	723,173	37,892	14,920	700,201	-.32
Southeast	662,056	0	21,668	683,724	.33
1-299 cows	275,248	0	10,834	286,082	.39
300 or more cows	386,808	0	10,834	397,642	.28
Southern Plains	439,354	30,921	10,822	419,255	-.46
1-349 cows	347,237	24,438	0	322,799	-.70
350 or more cows	92,117	6,483	10,822	96,456	.47
U.S. total	10,833,991	711,132	231,462	10,354,321	-.44

Appendix table 36—Scenario IV ($11.10 support price): Change in farm numbers with bST by region and farm size, 1986-96

Item	Farm numbers 1986	Removals	Additions	1996	Annual percentage change
	Number				Percent
Appalachia	11,562	452	0	11,110	-0.39
1-99 farms	9,089	325	0	8,764	-.36
100-199 farms	2,178	112	0	2,066	-.51
200 or more farms	296	15	0	280	-.51
Corn Belt	32,709	248	0	32,460	-.08
1-99 farms	30,904	0	0	30,904	.00
100 or more farms	1,805	248	0	1,556	-1.38
Lake States	67,067	3,534	472	64,005	-.46
1-99 farms	63,926	3,020	0	60,907	-.47
100-199 farms	2,812	514	314	2,612	-.71
200 or more farms	328	0	158	486	4.81
Northeast	49,759	5,664	494	44,589	-1.04
1-49 farms	30,028	806	0	29,222	-.27
50-99 farms	15,609	4,344	0	11,265	-2.78
100-149 farms	2,753	333	0	2,420	-1.21
150-249 farms	1,028	137	326	1,217	1.84
250 or more farms	341	45	169	465	3.64
Pacific	8,595	295	71	8,372	-.26
1-249 farms	5,622	181	0	5,441	-.32
250-499 farms	2,191	73	55	2,173	-.08
500 or more farms	782	41	16	757	-.32
Southeast	2,848	0	105	2,953	.37
1-299 farms	2,193	0	86	2,280	.39
300 or more farms	655	0	18	674	.28
Southern Plains	2,460	173	24	2,311	-.60
1-349 farms	2,252	158	0	2,094	-.70
350 or more farms	208	15	24	218	.47
U.S. total	175,000	10,366	1,167	165,801	-.53

Appendix table 37—Scenario IV ($11.10 support price): Change in cow numbers without bST by region and farm size, 1986-96

Item	Cow numbers: 1986	Removals	Additions	1996	Annual percentage change
	Number				Percent
Appalachia	769,374	33,143	0	736,231	-0.43
1-99 cows	438,863	15,700	0	423,163	-.36
100-199 cows	254,755	13,556	0	241,199	-.53
200 or more cows	75,756	3,887	0	71,869	-.51
Corn Belt	1,366,364	34,370	0	1,331,994	-.25
1-99 cows	1,153,823	0	0	1,153,823	.00
100 or more cows	212,541	34,370	0	178,171	-1.62
Lake States	3,499,604	366,950	134,732	3,267,386	-.66
1-99 cows	3,079,294	318,726	0	2,760,568	-1.04
100-199 cows	341,040	48,224	67,366	360,182	.56
200 or more cows	79,270	0	67,366	146,636	8.50
Northeast	2,231,800	460,261	167,392	1,938,931	-1.31
1-49 cows	837,237	51,903	0	785,334	-.62
50-99 cows	898,748	324,254	0	574,494	-3.61
100-149 cows	255,396	44,124	0	211,272	-1.73
150-249 cows	146,479	26,307	83,696	203,868	3.92
250 or more cows	93,940	13,673	83,696	163,963	7.45
Pacific	1,865,439	113,057	42,722	1,795,104	-.38
1-249 cows	551,670	18,790	0	532,880	-.34
250-499 cows	590,596	24,122	21,361	587,835	-.05
500 or more cows	723,173	70,145	21,361	674,389	-.68
Southeast	662,056	0	23,628	685,684	.36
1-299 cows	275,248	0	11,814	287,062	.43
300 or more cows	386,808	0	11,814	398,622	.31
Southern Plains	439,354	32,346	11,181	418,189	-.48
1-349 cows	347,237	25,648	0	321,589	-.74
350 or more cows	92,117	6,698	11,181	96,600	.49
U.S. total	10,833,991	1,040,127	379,655	10,173,519	-.61

Appendix table 38--Scenario IV ($11.10 support price): Change in farm numbers without bST by region and farm size, 1986-96

Item	Farm numbers 1986	Removals	Additions	1996	Annual percentage change
	Number				Percent
Appalachia	11,562	456	0	11,106	-0.39
1-99 farms	9,089	325	0	8,764	-.36
100-199 farms	2,178	116	0	2,062	-.53
200 or more farms	296	15	0	280	-.51
Corn Belt	32,709	292	0	32,417	-.09
1-99 farms	30,904	0	0	30,904	.00
100 or more farms	1,805	292	0	1,513	-1.62
Lake States	67,067	7,014	834	60,887	-.92
1-99 farms	63,926	6,617	0	57,310	-1.03
100-199 farms	2,812	398	555	2,970	.56
200 or more farms	328	0	279	607	8.50
Northeast	49,759	8,551	892	42,100	-1.54
1-49 farms	30,028	1,862	0	28,166	-.62
50-99 farms	15,609	5,979	0	9,630	-3.83
100-149 farms	2,753	476	0	2,277	-1.73
150-249 farms	1,028	185	587	1,431	3.92
250 or more farms	341	50	305	596	7.47
Pacific	8,595	380	102	8,318	-.32
1-249 farms	5,622	191	0	5,431	-.34
250-499 farms	2,191	109	79	2,161	-.13
500 or more farms	782	80	23	725	-.73
Southeast	2,848	0	114	2,962	.40
1-299 farms	2,193	0	94	2,287	.43
300 or more farms	655	0	20	675	.30
Southern Plains	2,460	181	25	2,304	-.63
1-349 farms	2,252	166	0	2,086	-.74
350 or more farms	208	15	25	218	.49
U.S. total	175,000	16,875	1,968	160,093	-.85

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